UNITED STATES AIR FORCE
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

ENVIRONMENTAL RESTORATION PROGRAM

FOURTH CERCLA FIVE-YEAR REVIEW REPORT

JBER-ELMENDORF, ALASKA

FINAL
MARCH 2014

UNITED STATES AIR FORCE
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

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LEAD AGENCY ACCEPTANCE
FOURTH FIVE-YEAR REVIEW, JBER-ELMENDORF, ALASKA

This signature sheet documents the United States Air Force acceptance of the Fourth Five-Year Review for JBER-Elmendorf.

BRIAN P. DUFFY
Colonel, United States Air Force
Commander

DATE

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ACRONYMS AND ABBREVIATIONS

673 CES	673d Civil Engineer Squadron
AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
AFB	Air Force Base
amsl	above mean sea level
ARAR	applicable or relevant and appropriate requirements
bgs	below ground surface
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	chemical of concern
COPC	contaminant of potential concern
DCA	dichloroethane
DCE	dichloroethene
DNAPL	dense nonaqueous phase liquid
DRO	diesel-range organics
EPA	U.S. Environmental Protection Agency
ERP	Environmental Restoration Program (formerly known as Installation Restoration Program – *see* IRP)
ESD	explanation of significant differences
FFA	Federal Facility Agreement
GRO	gasoline-range organics
HVE	high-vacuum extraction
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program (now known as Environmental Restoration Program – *see* ERP)
Jacobs	Jacobs Engineering Group Inc.
JBER	Joint Base Elmendorf-Richardson
JBER-E	Joint Base Elmendorf-Richardson – Elmendorf (formerly Elmendorf Air Force Base)
LUC	land-use control
MCL	maximum contaminant level

ACRONYMS AND ABBREVIATIONS (Continued)

mg/L	milligrams per liter
mg/kg	milligrams per kilogram
MNA	monitored natural attenuation
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NFA	no further action
NPL	National Priorities List
O&M	operations and maintenance
OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCA	tetrachloroethane
PCE	tetrachloroethene
RAO	remedial action objectives
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RRO	residual-range organics
SARA	Superfund Amendments and Reauthorization Act (1986)
SVE	soil vapor extraction
SWQC	surface water quality criteria
TBC	to be considered
TAH	total aromatic hydrocarbons
TAqH	total aqueous hydrocarbons
TCA	trichloroethane
TCE	trichloroethene
USAF	U.S. Air Force
UST	underground storage tank
UU/UE	unlimited use and unrestricted exposure
VOC	volatile organic compound
µg/L	micrograms per liter

EXECUTIVE SUMMARY

The U.S. Air Force (USAF) 673d Civil Engineer Squadron conducted the Fourth Five-Year Review of selected remedies for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites on Joint Base Elmendorf-Richardson (JBER)-Elmendorf, Alaska, beginning in May 2012. This report presents the results of the review for the JBER-Elmendorf (JBER-E) sites.

The purpose of this five-year review is to ensure that remedies selected in each of the records of decision (ROD) at JBER-E are performing effectively and continue to be protective of human health and the environment. This review evaluates the selected remedy and implementation status, identifies discrepancies, and makes recommendations for resolving any identified discrepancies or to improve performance of the selected remedies. This statutory review is required by CERCLA. All of the RODs for this National Priorities List site were signed after the effective date of the Superfund Amendments and Reauthorization Act of 1986 (SARA) and some of the selected remedies result in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure (UU/UE).

The contaminant sources at JBER-E are grouped into six areas including operable unit (OU) 1, OU2, OU4, OU5, OU6, and DP098. The selected remedies vary by site and have included contaminated soil and debris removal; land-use controls (LUC), also known as institutional controls; natural attenuation of contaminated groundwater; and operation and monitoring of several active remediation systems including high-vacuum extraction, a constructed wetland treatment cell, and in situ bioventing. The triggering action date for this fourth review is the date EPA signed the *Third Five-Year Review Report*, which was March 17, 2009.

The Five-Year Review Summary Form included on the following pages presents issues identified during this review, associated recommendations, follow-up actions, and protectiveness statements for each OU or site.

Overall, this five-year review found that the remedies had been constructed and, in general, were operating and functioning as intended by RODs for each of the OUs and DP098. Remaining contamination in the groundwater at OU1 appears to be a result of onsite migration from an upgradient source, not from the sources addressed in the OU1 ROD. At OU2, OU4, OU5, OU6, and DP098, it is expected to take longer to achieve cleanup goals than predicted in the RODs.

This five-year review found that the selected remedy at OU2 is currently protective, but may not be protective in the future. Although the implemented remedial process is functioning as intended, the cleanup date predicted in the OU2 ROD is unlikely to be met. The ROD stipulates that the contingency remedy will be implemented should the USAF, in consultation with the U.S. Environmental Protection Agency and the Alaska Department of Environmental Conservation, determine that the selected remedy is not expected to meet cleanup goals within a reasonable time frame, which in this case is 2016.

This five-year review found that the selected remedy at OU6 is currently protective, but may not be protective in the future. In general, the remedial process is functioning as intended; however, the current cleanup date prediction exceeds the timeframe presented in the ROD.

This five-year review found that the protectiveness determinations of the implemented remedies for OU4, OU5, and DP098 could not be made at the time of this review. The protectiveness determinations will be dependent on evaluations from future vapor intrusion studies at the OUs.

Protectiveness statements for OU1, OU2, OU4, OU5, OU6, and DP098 are presented in Section 10.0.

FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site Name: JBER-E (Formerly Elmendorf Air Force Base)		
EPA ID: AK8570028649		
Region: X	**State:** Alaska	**City/County:** Anchorage
SITE STATUS		
NPL Status: Currently on the Final NPL		
Multiple OUs? Yes	**Has the site achieved construction completion?** No	
REVIEW STATUS		
Lead agency: USAF **If "Other Federal Agency" was selected above, enter Agency name:** N/A		
Author name (Federal or State Project Manager): Jacobs Engineering Group Inc. on behalf of the 673d Civil Engineer Squadron, Asset Management Flight, Natural Resources Element, Cleanup Section Federal Project Manager: Gary Fink		
Author affiliation: Contractor		
Review period: March 17, 2009 – March 17, 2014		
Dates of site inspection: July 16, 2012 – July 19, 2012; August 23, 2012; and June 10, 2013		
Type of review: Post-SARA Statutory Review		
Review number: 4 (four)		
Triggering action date: March 17, 2009		
Due date ***(five years after triggering action date)*****:** March 17, 2014		

Notes:
N/A = not applicable
NPL = National Priorities List
USAF = United States Air Force

Five-Year Review Summary Form (Continued)

<table>
<tr><th colspan="5">ISSUES/RECOMMENDATIONS</th></tr>
<tr><td colspan="5">OU(s) without Issues/Recommendations Identified in the Five-Year Review:</td></tr>
<tr><td colspan="5">None</td></tr>
<tr><td colspan="5">Issues and Recommendations Identified in the Five-Year Review:</td></tr>
<tr><td rowspan="3">OU(s): 1</td><td colspan="4">Issue Category: Remedy Performance</td></tr>
<tr><td colspan="4">Issue: An upgradient source of trichloroethene (TCE) and 1,1,2,2-tetrachloroethane is contaminating groundwater in the northwest portion of the Site LF059 land use control area. Although TCE concentrations at affected wells are relatively low, TCE shows no decreasing trends.

The 1994 OU1 ROD predicted that contaminant levels in groundwater would meet acceptable human risk levels and Safe Drinking Water standards within five years of implementing the monitoring program (by 1999).</td></tr>
<tr><td colspan="4">Recommendation: Pursue a “Response Complete” status for LF059. Delineate the upgradient plume affecting LF059 that likely originates at closed site LF007. Pursue re-opening LF007 under the CERCLA program and manage the groundwater plume that is affecting part of LF059 as part of the upgradient source.</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Implementing Party</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>No</td><td>Yes</td><td>USAF</td><td>EPA/ADEC</td><td>12/31/2016</td></tr>
<tr><td rowspan="3">OU(s): 2</td><td colspan="4">Issue Category: Remedy Performance</td></tr>
<tr><td colspan="4">Issue: Although chemicals of concern (COC) in the groundwater at ST041 are showing decreasing trends, RAOs will not be met within the 21-year timeframe specified in the ROD (by 2016). Additionally, the ROD identifies a “contingent remedy” that will be implemented if USAF, in consultation with ADEC and EPA, determine that natural attenuation is not occurring at an acceptable rate.</td></tr>
<tr><td colspan="4">Recommendation: Determine the rate of natural attenuation at OU2. Evaluate whether the contingency remedy should be implemented.</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Implementing Party</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>No</td><td>Yes</td><td>USAF</td><td>EPA/ADEC</td><td>12/31/2016</td></tr>
</table>

Five-Year Review Summary Form (Continued)

Issues and Recommendations Identified in the Five-Year Review:				
OU(s): 4	**Issue Category:** Remedy Performance			
	Issue: The 1995 OU4 ROD established 2008 as the groundwater cleanup date (a 13-year timeframe); however, concentrations of benzene at SD025 remain at least an order of magnitude above cleanup levels. No decreasing trends for two of the COCs (toluene and benzene) could be established and an increasing trend was identified for ethylbenzene. Therefore, a cleanup date cannot be predicted at this time.			
	Recommendation: Evaluate alternative remedial strategies to accelerate attainment of cleanup levels in groundwater at SD025.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	USAF	EPA/ADEC	12/31/2016
OU(s): 4	**Issue Category:** Monitoring			
	Issue: Manned facilities are present in the vicinity of the contaminant plumes associated with the OU4 active sites FT023, SD025, and SD029 indicating a potential for vapor intrusion to occur at those facilities.			
	Recommendation: A vapor intrusion evaluation that provides multiple lines of evidence should be conducted in accordance with EPA guidance for each occupied facility that is in proximity to the volatile organic compound (VOC) plume(s) at FT023, SD025, and SD029. Vapor intrusion evaluations should be conducted prioritizing buildings with the most vulnerable populations (schools, day cares, offices, residences).			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	USAF	EPA/ADEC	12/31/2016

Five-Year Review Summary Form (Continued)

<table>
<tr><th colspan="5">Issues and Recommendations Identified in the Five-Year Review:</th></tr>
<tr><td rowspan="3">OU(s): 5</td><td colspan="4">Issue Category: Monitoring</td></tr>
<tr><td colspan="4">Issue: Based on the large historical release of fuel identified in the Remedial Investigation (RI) Report, the potential exists for significant residual fuel contamination to remain in the soil that may act as a source of groundwater contamination. The extent of the soil source area affecting groundwater and thereby contributing to the benzene and petroleum hydrocarbon contamination detected in seeps OU5SP-01 and OU5SP-02 is not well delineated.</td></tr>
<tr><td colspan="4">Recommendation: Identify the extent of soil contamination that is resulting in elevated concentrations of benzene and petroleum products identified in seeps OU5SP-01 and OU5SP-02. An assessment of residual soil contamination will be needed to predict the timeframe to meet RAOs at seeps OU5SP-01 and OU5SP-02.</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Implementing Party</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>No</td><td>Yes</td><td>USAF</td><td>EPA/ADEC</td><td>12/31/2017</td></tr>
<tr><td rowspan="3">OU(s): 5</td><td colspan="4">Issue Category: Monitoring</td></tr>
<tr><td colspan="4">Issue: The 2006 vapor intrusion screening evaluation performed for TCE in the vicinity of the Fairchild Avenue Plume and the Dallas base housing area utilized toxicity information that has since been updated. Additionally, no supplemental testing has been conducted to support the findings of the screening evaluation.</td></tr>
<tr><td colspan="4">Recommendation: A vapor intrusion evaluation that provides multiple lines of evidence should be conducted in accordance with EPA guidance for each occupied facility that is in proximity to the TCE plumes at OU5. Vapor intrusion evaluations should be conducted prioritizing buildings with the most vulnerable populations (schools, day cares, offices, residences).</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Implementing Party</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>No</td><td>Yes</td><td>USAF</td><td>EPA/ADEC</td><td>12/31/2016</td></tr>
</table>

Five-Year Review Summary Form (Continued)

Issues and Recommendations Identified in the Five-Year Review:				
OU(s): 5	**Issue Category:** Remedy Performance			
	Issue: Groundwater monitoring results at OU5 indicate that natural attenuation remedies are generally decreasing COC concentrations. However, the process is slower than anticipated in the 1995 ROD, and it is unlikely that concentrations of COCs will fall below their respective cleanup levels prior to the ROD-specified cleanup date (2025).			
	Recommendation: Utilize the findings from the *ST37 Plume and Source Area Groundwater Investigation Report* and continue to delineate the plume boundaries and potential source areas at OU5. Evaluate alternative remedial strategies to accelerate attainment of cleanup levels in groundwater.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	USAF	EPA/ADEC	12/31/2017
OU(s):6	**Issue Category:** Remedy Performance			
	Issue: Review of historical data indicate no decreasing trend and an increasing trend for some COCs in the groundwater at LF004 South, WP014 (OU6MW-46), and SD015. It is not possible to predict a reliable cleanup date for these OU6 sites.			
	Recommendation: Perform remedial process optimization for LF004 South, WP014, and SD015 since it does not appear that there will be sufficient progress in the timeframe established in the ROD.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	USAF	EPA/ADEC	12/31/2016

Five-Year Review Summary Form (Continued)

Issues and Recommendations Identified in the Five-Year Review:				
OU(s):6	**Issue Category:** Monitoring			
	Issue: Based on the maximum concentration of 2-methylnaphthalene identified in the groundwater at WP014 during the time of the ROD (630 micrograms per liter [μg/L]) the calculated risk exceeds the hazard quotient threshold for non-cancer chemicals.			
	Recommendation: Based on the potential risk associated with the maximum concentration of 2-methylnaphthalene detected in the groundwater at WP014 during the time of the ROD, the analyte should be resampled for to determine the concentration present at the site and to determine if current concentrations present an unacceptable risk.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	USAF	EPA/ADEC	12/31/2016
OU(s): DP098	**Issue Category:** Monitoring			
	Issue: Indoor air sampling at DP098 appears to indicate that no unacceptable risk is occurring. However, the historical efforts do not meet the current standard of multiple lines of evidence.			
	Recommendation: A vapor intrusion evaluation that provides multiple lines of evidence should be conducted in accordance with EPA guidance for each occupied facility that is in proximity to the TCE plumes at DP098. Vapor intrusion evaluations should be conducted prioritizing buildings with the most vulnerable populations (schools, day cares, offices, residences).			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	USAF	EPA/ADEC	12/31/2016

Five-Year Review Summary Form (Continued)

PROTECTIVENESS STATEMENT(S)		
Operable Unit: OU1	*Protectiveness Determination:* Short-Term Protective	*Addendum Due Date (if applicable):* None
Protectiveness Statement: The remedy at OU1 is currently protective of human health and the environment because LUCs restrict access to the subsurface. However, in order for the remedy to be protective in the long-term, the upgradient plume affecting LF059, likely originating at closed site LF007, will need to be fully delineated.		
Operable Unit: OU2	*Protectiveness Determination:* Short-Term Protective	*Addendum Due Date (if applicable):* None
Protectiveness Statement: The remedy at ST041 is currently protective of human health and the environment because LUCs are preventing exposure to contaminated groundwater and soil. However, in order for the remedy to be protective in the long-term, the remedial processes selected in the ROD will need to be optimized or the contingency remedy will need to be selected and implemented because it does not appear that there will be sufficient progress in the timeframe established in the ROD.		
Operable Unit: OU4	*Protectiveness Determination:* Protectiveness Deferred	*Addendum Due Date:* December 31, 2016
Protectiveness Statement: Protectiveness determination of the remedy at OU4 is deferred until the potential impacts associated with the vapor intrusion pathway at the site are evaluated. The vapor intrusion assessment is expected to be performed in 2016. Vapor intrusion evaluations will be conducted prioritizing buildings with the most vulnerable populations (schools, day cares, offices, residences).		
Operable Unit: OU5	*Protectiveness Determination:* Protectiveness Deferred	*Addendum Due Date:* December 31, 2016
Protectiveness Statement: Protectiveness determination of the remedy at OU5 is deferred until the potential impacts associated with the vapor intrusion pathway at the site are evaluated. The vapor intrusion assessment is expected to be performed in 2016. Vapor intrusion evaluations will be conducted prioritizing buildings with the most vulnerable populations (schools, day cares, offices, residences). Delineation of the OU5 TCE source areas and plume boundaries is needed to ensure long-term protectiveness.		

Five-Year Review Summary Form (Continued)

PROTECTIVENESS STATEMENT(S)		
Operable Unit: OU6	*Protectiveness Determination:* Short-Term Protective	*Addendum Due Date (if applicable):* None
Protectiveness Statement: The remedies at OU6 currently protect human health and the environment because LUCs are preventing exposure to contaminated groundwater and soil. However, in order for the remedy to be protective in the long-term, the remedial action selected in the ROD will need to be optimized because it does not appear that there will be sufficient progress in meeting groundwater cleanup levels in the timeframe established in the ROD. LF002 meets the ROD-specified cleanup levels; therefore, a "Response Complete" determination with continued implementation of LUCs is recommended for the site.		
Operable Unit: DP098	*Protectiveness Determination:* Protectiveness Deferred	*Addendum Due Date:* December 31, 2016
Protectiveness Statement: Protectiveness determination of the remedy at DP098 is deferred until the potential impacts associated with the vapor intrusion pathway at the site are evaluated. The vapor intrusion assessment is expected to be performed in 2016. Vapor intrusion evaluations will be conducted prioritizing buildings with the most vulnerable populations (schools, day cares, offices, residences).		

Notes:
ADEC = Alaska Department of Environmental Conservation
ARAR = applicable or relevant and appropriate requirements
COC = chemical of concern
EDB = ethylene dibromide
EPA = U.S. Environmental Protection Agency
JBER-E = Joint Base Elmendorf-Richardson formerly Elmendorf Air Force Base
LUC = land-use control
MCL = maximum contaminant level
MNA = monitored natural attenuation
NFA = no further action
NPL = National Priorities List
OU = operable unit
RAO = remedial action objective
ROD = record of decision
SARA = Superfund Amendments and Reauthorization Act (1986)
TCE = trichloroethene
USAF = U.S. Air Force
VOC = volatile organic compound
μg/L = micrograms per liter

1.0 INTRODUCTION

The U.S. Air Force (USAF) 673d Civil Engineer Squadron (673 CES) conducted the fourth five-year review of the remedial actions at the Joint Base Elmendorf-Richardson (JBER)-Elmendorf (E) National Priorities List (NPL) Site near Anchorage, Alaska (Appendix A, Figure A-1) beginning in July of 2012.

In August 1990, the former Elmendorf Air Force Base (AFB) (referred to as JBER-E throughout this report) was placed on the NPL. In November 1991, a Federal Facilities Agreement negotiated between the U.S. Environmental Protection Agency (EPA) and the Alaska Department of Environment Conservation (ADEC) established the procedural framework and a cleanup schedule for all Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) activities conducted on JBER-E. The USAF's investigation of contaminated sites at JBER-E began under the Environmental Restoration Program (formerly known as Installation Restoration Program). The objectives of the Environmental Restoration Program (ERP) are to assess sites where potentially hazardous material may exist and to develop and recommend remedial actions for those sites that pose a threat to human health and welfare or the environment. The ERP is the basis for response actions under the provisions of the CERCLA.

Elmendorf AFB was identified for realignment with Fort Richardson during the 2005 Base Realignment and Closure (BRAC) selection process. On October 1, 2010, Elmendorf AFB, located just north of Anchorage, and Fort Richardson, located northeast of Anchorage, merged under the joint basing initiative to form JBER. While military missions of the USAF and the U.S. Army units will remain separate, JBER consolidates service-specific programs that perform the installation support functions, including environmental remediation services. The USAF is now responsible for the cleanup of JBER sites formerly managed by the U.S. Army using the Environmental Restoration Agreements formerly between the U.S. Army, the EPA, and ADEC such as the Fort Richardson Federal Facility Agreement (FFA), State-Fort Richardson Environmental Restoration Agreement, and Federal Facility Compliance Agreement.

Despite the consolidation of the JBER environmental program, a separate five-year review report was generated for each of the former installations (Elmendorf AFB and Fort Richardson). This five-year review has been conducted for the sites originally assigned to Elmendorf AFB under the previously signed Records of Decision (ROD).

1.1 PURPOSE

The purposes of this five-year review are twofold: to evaluate the implementation and performance of the remedial actions that were selected in each ROD for OU1, OU2, OU4, OU5, OU6, and DP098, including those that have been further revised in an explanation of significant differences (ESD) or memorandum to a site file, and to determine whether these actions remain protective of human health and the environment. The methods, findings, and conclusions of five-year reviews identify issues found through an examination of the data collected in the past five years, if any, and provide recommendations to address them. These findings are documented in five-year review reports. This report covers activities that have occurred and conditions as they have developed since the previous five-year review for JBER-E, which was conducted in 2008.

This review is a post-SARA statutory review that is required because contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure (UU/UE). The start of construction of the OU2 interim remedial action on August 5, 1993 triggered the first five-year review, which was completed and signed by USAF on October 20, 1998 (USAF, 1998a). The second five-year review was completed and signed by USAF on December 17, 2003 (USAF, 2003a). The third five-year review was signed by the USAF representative on January 27, 2009 (USAF, 2008a), which serves as the trigger date for this fourth five-year review.

The USAF (673 CES) has conducted this policy five-year review pursuant to CERCLA [Title 42, Section 9621(c) of the U.S. Code (USC)]; the National Contingency Plan (NCP); Executive Order 12580 (January 23, 1987); and Section 19.1 of the FFA for Elmendorf AFB dated September 1991 (EPA, 1991).

CERCLA §121 states:

If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.

The EPA interpreted this requirement further in the NCP; Title 40, Section 300.430(f)(4)(ii) of the Code of Federal Regulations (CFR) states:

If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.

Section 19.1 of the FFA (EPA, 1991) for Elmendorf AFB states:

If a remedial action is selected that results in any hazardous substances, pollutants, or contaminants remaining at the Site, the Parties shall review such remedial action no less often than each five (5) years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. The U.S. EPA Project Manager and the ADEC Project Manager shall advise the USAF Project Manager of their findings in this regard. If any Party determines that additional action is required, the Agreement may be amended pursuant to Part XXXIII.

This document is consistent with the EPA Office of Solid Waste and Emergency Response (OSWER) *Comprehensive Five-Year Review Guidance*, No. 9355.7-03B-P (EPA, 2001), OSWER *Clarifying the Use of Protectiveness Determinations for CERCLA Five-Year Reviews*, No. 9200.2-111 (EPA, 2012a), and OSWER *Assessing Protectiveness at Sites for Vapor Intrusion*, No. 9200.2-84 (EPA, 2012b). Consistent with the FFA (EPA, 1991), this Five-Year Review Report was submitted to the EPA and ADEC project managers for document review. This review is limited to only those sites being remediated under CERCLA authority. Other areas at JBER-E with a history of contamination that are not included in this five-year review include the following:

- A brief description of OU3 and Site SA100 are included in Table 1-1, but these areas are not covered in depth because contaminants are below cleanup levels and the sites are closed, as documented in the 1998, 2003, and 2008 five-year review reports (USAF, 1998a, 2003a, and 2008a). These areas were not included in this five-year review because there are no remedies to evaluate.

- Another site, SS022, was not evaluated in this five-year review because it is still in the investigation phase; risks have not yet been assessed and remedies have not yet been selected.
- Two other sites, SS083 and SA099, were also mentioned in the 2003 five-year review, but these sites were subsequently removed from CERCLA and addressed under state programs due to the nature of contaminants. Therefore, SS083 and SA099 are not required to be evaluated under this five-year review.
- An additional site, SS109 located near the F-22 Weapons Release Shop is currently in the remedial investigative stage. This CERCLA site will be addressed in a future review period after the remedy has been selected.

1.2 OVERVIEW

This five-year review was conducted beginning in January 2012 by the project team consisting of the USAF Remedial Project Managers with contracted environmental engineering support. This effort included a review and evaluation of the ROD requirements and any decisions, changes and/or recommendations that were put in place after the ROD was signed, the work that has been done to satisfy those requirements, current and past monitoring data, and the current status of the remedies and the physical condition of the sites. Visits were made to each active CERCLA site where an action has been performed or is still in progress. Some of the OUs include sites designated as no further action (NFA) at the time the ROD was signed, or have since met cleanup requirements. NFA and closed CERCLA sites were not included in this review. Land-use controls (LUC), discussed in detail in Section 4.7, are being maintained at each active site until it is demonstrated that site contaminant concentrations are at or below levels that allow for UU/UE (Appendix A, Figure A-2). Note that the USAF term LUCs is equivalent to the term institutional controls used in several of the RODs. Following written regulatory concurrence, where applicable, that all response actions are complete (i.e., cleanup levels have been met, no LUCs are in effect, and no additional funds will be expensed), the USAF considers a site "closed." A brief description and status of all OUs or active sites at JBER-E is presented in Table 1-1.

Table 1-1
Operable Unit Status

OU	Sites	Included in this review?	Description	Status
OU1	**LF005** (NFA) **LF007** (NFA) **LF013** (NFA) **OT056** (NFA) LF059	Yes	OU1 consists of five general waste disposal areas where various types of material were disposed. The ROD (1994) focused on groundwater monitoring and LUCs. A memorandum to the site file in 1997 provided greater detail on implementation of LUCs. NFA pursuant to formal closure was achieved for LF005, LF007, LF013, and OT056 in July 2004.	Groundwater monitoring is ongoing at LF059 and LUCs are documented in the January 2010 *OUs 1, 2, 4, and 5 LUC Memorandum to the Site File*, the Base General Plan, and the May 2011 673d Air Base Wing Instruction 32-7003 *Land Use Control Management*.
OU2	**ST020** (NFA) ST041	Yes	OU2 includes two UST sites: ST020 and ST041. The tank at ST020 was cleaned, demolished, and removed from the site in 1990. An interim ROD (1992) for the groundwater contamination at ST041 resulted in the installation of a free-product and dissolved-phase recovery/treatment system in 1993. The ROD (1995) designated ST020 as NFA and focused on ST041. Four USTs and wood piping were cleaned and buried in place, the tanks were filled with inert material in 1996 and the contaminated soil was treated on base. The steel piping was removed, decontaminated, and recycled. The sampling frequency for the surface water point of compliance and seeps at ST041 have been clarified in the *Memorandum to the Site File: Operable Unit 2* (USAF, 2011e).	The treatment system performed as designed. Beginning in February 1997, no recoverable quantities of fuel product were observed and the system was shut down in April 1999. Long-term groundwater and surface water monitoring is ongoing. LUCs for OU2 are documented in the January 2010 *OUs 1, 2, 4, and 5 LUC Memorandum to the Site File*, the Base General Plan, and the May 2011 673d Air Base Wing Instruction 32-7003 *Land Use Control Management.*

Table 1-1
Operable Unit Status (Continued)

OU	Sites	Included in this review?	Description	Status
OU3	**SD016** (NFA) **SS021** (NFA) **SD031** (NFA) **SD052** (NFA)	No	OU3 consisted of three sources and one receptor area. PCB-contaminated soils were excavated and disposed in 1998. The *Five-Year Review* (USAF, 1998a) reported confirmation samples were below ROD-defined cleanup levels, allowing UU/UE[1].	This OU is not included as part of the fourth five-year review because the sites are closed.
OU4	**SS010** (NFA) **SS018** (NFA) FT023 SD024 SD025 **SD026** (NFA) **SD027** (NFA) SD028 SD029 **SD030** (NFA)	Yes	OU4 consists of 10 source areas including maintenance facilities, a fire training area, and an asphalt drum storage/processing area. The OU4 ROD focused on monitoring to assess contaminant migration and natural attenuation progress to attain cleanup levels in shallow groundwater and shallow soils and in situ bioventing to treat deep soils. LUCs were established to prevent exposure to the groundwater and soils at the site. A memorandum to the site file established a decision guide for monitoring well sampling frequency in 2003 (Appendix F).	LUCs (at all sites within OU4) and groundwater monitoring (FT023, SD025, and SD029) are ongoing; LUCs are documented in the January 2010 *OUs 1, 2, 4, and 5 LUC Memorandum to the Site File*, the Base General Plan, and the May 2011 673d Air Base Wing Instruction 32-7003 *Land Use Control Management.* Concentrations of COCs are below the ROD-established cleanup levels at SD024 and SD028. Deep soil sampling was conducted at FT023 in 2009 as required in preparation for closure; soil samples exhibited concentrations of contaminants below applicable cleanup levels; therefore, the bioventing system was shut down and decommissioned that same year. Cleanup levels have been met for shallow and deep soils at all OU4 sites.

Table 1-1
Operable Unit Status (Continued)

OU	Sites	Included in this review?	Description	Status
OU5	ST037 **ST038** (NFA) **SD040** (NFA) **SS042** (NFA) **ST046** (NFA) **SS053** (NFA)	Yes	OU5 is located along the southern boundary of the base. Upgradient shallow groundwater that migrates to this area is treated in OU5. The 1995 ROD called for:(1) removal and treatment of soil at ST037; (2) monitoring to estimate rate of natural attenuation of shallow aquifer, seep, and surface water; (3) passive drainage of seep water to a constructed Wetland Remediation System; (4) gravel placed at seep areas; and (5) LUCs prohibiting groundwater usage. A memorandum to the site file established a decision guide for monitoring well sampling frequency in 2003. A memorandum to the site file in 2005 incorporated additional contaminated seeps into the Wetland Remediation System for treatment, and established decision guides to determine how seeps will be incorporated into or removed from the Wetland Remediation System in the future based on contaminant concentrations. An optimization study performed from 2008 through 2010 determined that the Wetland Remediation System could achieve treatment goals passively, and the pump stations were subsequently shut down. A memorandum to the site file was generated in 2011 describing the transition of the Wetland Remediation System from an 'active' to a 'passive' remediation system.	Wetland Remediation System was constructed in 1996. Contaminated soils from ST037 were removed and treated by 1999. Natural attenuation and monitoring, O&M related to the passive operation of the Wetland Remediation System, and LUCs are ongoing. LUCs for OU5 are documented in the January 2010 *OUs 1, 2, 4, and 5 LUC Memorandum to the Site File*, the Base General Plan, and the May 2011 673d Air Base Wing Instruction 32-7003 *Land Use Control Management.*

Table 1-1
Operable Unit Status (Continued)

OU	Sites	Included in this review?	Description	Status
OU6	LF002 LF003 LF004 **SS019** (NFA) WP014 SD015 **SD073** (NFA)	Yes	OU6 consists of six source areas. A seventh source area, SS019, was included in the OU6 ROD but was cleaned up in 1995. The 1997 ROD designated SS019 and SD073 as NFA and selected remedies for the remaining sites included groundwater monitoring at LF002, LF004 South, WP014 and SD015, removal of free product from the water table at LF004 and WP014, debris removal at LF004, groundwater treatment at SD015, surface debris removal and limited soil cover at LF002, and LUCs at all active sites. A memorandum to the site file established a decision guide for monitoring well sampling frequency in 2003. An ESD in 2007 established that the SD015 high-vacuum extraction system could be terminated when operations became ineffective, and established groundwater monitoring as the remedy for contaminated groundwater. The ESD also updated the cleanup level for 1,1,2,2-PCA and clarified implementation of LUCs. A memorandum to the site file in 2008 removed the beach from the debris removal effort at LF004.	LF002 surface debris removal and limited soil cover placement have been completed. The SD015 high-vacuum extraction treatment system removed all recoverable contaminants and was shut down in 2007, and the groundwater remedy transitioned to monitoring. Shallow and deep soil met cleanup levels for all soil COCs in 2005. However, contaminated soil was encountered in 2008 and approximately 250 cubic yards of contaminated soil was removed in 2009. Additional investigation of the nature and extent of remaining contamination in this area was completed in 2011. Contaminants found in deep soils did not exceed ROD cleanup levels. No recoverable free product has been detected at WP014 monitoring wells since 2005. Monitoring of groundwater at LF002, LF004 South, WP014, and SD015; LF004 debris removal; and LUCs are ongoing. According to the most recent monitoring data (USAF, 2013), the groundwater at LF002 has achieved cleanup levels. LUCs for OU6 are documented in the Base General Plan and the May 2011 673d Air Base Wing Instruction 32-7003 *Land Use Control Management*.

Table 1-1
Operable Unit Status (Continued)

OU	Sites	Included in this review?	Description	Status
NA	SS022	No	SS022 is located 1 mile east of the east/west runway at the Defense Reutilization and Marketing Office storage facility. This 22-acre site was closed with no further remedial action planned in 1991, but was re-opened when two tar seeps were discovered in 2002. The tar seeps were cleaned up and subsequent geophysical investigations indicated 15 subsurface anomalies. Site reconnaissance revealed a debris pile and a stressed vegetation area. The anomalies, debris pile, stressed vegetation area, and underlying groundwater have undergone field screening and were sampled for definitive analyses through 2009. An RI resulted in the discovery of radioactive waste and expansion of the site boundaries. The SS022 site was added to the Federal Facilities Agreement (EPA, 1991) on May 14, 2008. The schedule for delivery of primary and secondary documents was revised after discovery of radioactive waste.	Site SS022 is not included in this five-year review because it is still in the investigative stage. Investigations began in 2007 and the Draft RI and another proposed schedule change are currently undergoing regulatory review.

Table 1-1
Operable Unit Status (Continued)

OU	Sites	Included in this review?	Description	Status
NA	SS109	No	SS109 is located on the west side of Talley Avenue on JBER-Elmendorf. Site boundaries include Building 17726 to the west and Building 16716 (Hangar 15) to the southwest. Prior to the construction of Building 17720, investigation activities revealed the presence of TCE- and PCE- contaminated soil. Contaminated soil from the F-22 Wetland Remediation System area was excavated and an SVE system was installed. Additionally, a ventilated stockpile was constructed to treat PCE- and TCE-contaminated soil using ex situ methods. The SVE system operated for 2 years before it was shut down; however, the vapor monitoring points were not decommissioned to allow the system to be brought back online if needed. The ventilated stockpile remains in place as there are still chemicals of concern above Alaska ADEC cleanup levels. PCE and TCE are the only chemicals of concern that remain.	Site SS109 is not included in this five-year review because it is still in the investigative stage.

Table 1-1
Operable Unit Status (Continued)

OU	Sites	Included in this review?	Description	Status
NA	DP098	Yes	DP098 consists of a single source area. The 2004 ROD selected limited source removal of chlorinated contaminants in soils, offsite treatment and disposal, MNA, and LUCs as remedies for DP098. The MNA component consists of: (1) natural attenuation of contaminants in groundwater, soil, and sediment; (2) a treatability study to determine the effectiveness of the natural attenuation at/around the 190-foot topographic contour; and (3) an evaluation/compilation of groundwater data collected during the first five years of monitoring.	The limited source removal was completed in 2005. Two treatability studies have been completed (one in 2005 and a second in 2010) where compounds have been introduced to the subsurface to enhance or facilitate contaminant degradation. Each method saw some success but also had some limitation in effectiveness or completeness of the compound degradation. The evaluation/compilation of groundwater data was completed in 2008. Monitoring of natural and enhanced attenuation and LUCs are ongoing. LUCs for DP098 are documented in the Base General Plan and the May 2011 673d Air Base Wing Instruction 32-7003 *Land Use Control Management*.

Notes:
[1] Unlimited use and unrestricted exposure (UU/UE) means that the selected remedy will place no restrictions on the potential use of land or other natural resources.
BOLD = Sites receiving NFA status at the time of the ROD.
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
EPA = Environmental Protection Agency
ESD = explanation of significant differences
LUC = land-use controls
NA = not applicable
NFA = No Further Action
O&M = operations and maintenance
MNA = monitored natural attenuation
PCB = polychlorinated biphenyl
ROD = Record of Decision
USAF = U.S. Air Force
UST = underground storage tank
UU/UE = unlimited use and unrestricted exposure
For additional definitions, see the Acronyms and Abbreviations section.

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2.0 SITE CHRONOLOGY

Important site events and relevant dates in the site chronology for each site covered in this five-year review are shown in Table 2-1.

Table 2-1
Chronology of Site Events

Event	OU1	OU2	OU4	OU5	OU6	DP098
Initial discovery of contamination and/or Preliminary Assessment [a] (sites in parentheses)	1983 (LF005, LF007, LF013)	1982 (ST041)	1983 (FT023, SD024, SD025, SD026, SD027, SD028, SD029, SD030)	1983 (ST037, ST038, SS042, SD040, ST046)	1983 (LF003, LF004, WP014, SD015)	1995
	1990 (OT056)				1988 (LF002)	
	1991 (LF059)	1986 (ST020)	1988 (SS010, SS018)	1988 (SS053)	1993 (SD073)	
Site Investigations	1986, 1988, 1990	1986, 1988, 1990	1986, 1990	1990	1988, 1990, 1993	1996, 1997, 1998, 1999
National Priorities List	August 1990: Elmendorf AFB was placed on the NPL list.					
FFA Signature	November 1991: FFA negotiated between USAF, EPA, and ADEC					
Removal Actions (sites in parentheses)	1995-96 (LF059)	1990 (ST020)	1993-94 (SS010)	--	1995 (SS019)	--
IRA ROD	--	December 1992	--	--	--	--
RI/FS Completed	January 1994	March 1994	September 1994	March 1994	December 1995	June 2003
ROD Signed	September 1994	May 1995	October 1995	February 1995	January 1997	June 2004
NFA Decision Documents (sites in parentheses)	--	1995 (ST020)	1993 (SD026, SD027, SD030, SS018)	1994 (ST038, SS042, SD040, ST046, SS053)	1997 (SS019, SD073)	--

Table 2-1
Chronology of Site Events (Continued)

Event	OU1	OU2	OU4	OU5	OU6	DP098
Remedial Design/Remedial Action Scope of Work	May 1995	June 1995	October 1995	February 1996	April 1997	November 2004
Remedial Design Complete	--	November 1995	September 1995	January 1996	September 1996	--
LUCs Implemented	March 1994	March 1995	June 1998	July 1998	August 1998	May 2002
Remedial Action Start	May 1995	September 1993: IRA July 1996: Tank Closure	November 1995	June 1996	June 1996	June 2004: Groundwater MNA 2005: Removal Action and Treatability Study
Construction Dates (start – finish)	August 1995 – November 1996	1993 (IRA), May – October 1996 (tank closure)	October – November 1995	June 1996-1997	October – November 1996	June 2004 – October 2008
ROD Amendments, ESDs, or Memoranda to the Site File	June 1997, January 2010	January 2010, March 2011	September 2003, January 2010	September 2003, March 2005, January 2010, June 2011	September 2003, March 2007, May 2008	--
Closure Reports (sites in parentheses)	2004 (LF005, LF007, LF013, OT056)	--	2006 (SS010)	--	--	--
Previous five-year reviews	1998, 2003, 2008	1998, 2003, 2008	1998, 2003, 2008	1998, 2003, 2008	1998, 2003, 2008	2008

Table 2-1
Chronology of Site Events (Continued)

Event	OU1	OU2	OU4	OU5	OU6	DP098
NPL Site Completion	*2084 – Expected NPL Completion Date for Elmendorf Air Force Base (now known as JBER-E)*					
Final Close-Out Report	*October 2084 – Expected date for final Close-Out Report for Elmendorf Air Force Base (now known as JBER-E)*					
Deletion from NPL	*October 2085* – Expected date for Elmendorf AFB (now known as JBER-E) to be taken off of the NPL List					

Notes:
[a]The Preliminary Assessment was a records search conducted as part of the USAF ERP.
ESD = explanation of significant differences
IRA = interim remedial action
For additional definitions, see the Acronyms and Abbreviations section.

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3.0 BACKGROUND

3.1 JBER-ELMENDORF LAND USE AND SITE DESCRIPTION

3.1.1 Land Use

JBER-E is composed of 13,804 acres and is within the Municipality of Anchorage, Alaska. It is bound on the west and north by the Knik Arm of Cook Inlet and on the east by JBER-Richardson (Appendix A, Figure A-1). Immediately to the south of JBER-E lies urban development within the Municipality of Anchorage. Land use varies across the base and consists of military support uses including industrial, commercial, residential, recreational, and undisturbed/vacant. The majority of the contaminated sites are located in or adjacent to industrial/commercial areas. Land use in adjacent, off-base locations is a mixture of industrial and residential. Two residential areas (Mountain View and Government Hill) are immediately adjacent to JBER-E. No CERCLA sites are located in the immediate vicinity of these areas. Past, current, and anticipated future specific land uses at the active CERCLA sites have not changed since the time of the RODs (USAF, 1994a [OU1]; 1995b [OU2]; 1995a [OU4]; 1995c [OU5]; 1997e [OU6]; and 2004a [DP098]), and are summarized in Table 3-1.

The Port of Anchorage expanded its facilities in 2007 and 2008 just outside of the OU6 LF004 boundary. The beach below LF004 was covered with fill material. In order to reflect the change in site conditions, the language of the LF004 remedy was changed from "annual debris removal from the beach" to "annual debris removal from the base of the bluff" (USAF, 2008e). The expanded Port facilities are outside of the JBER-E LF004 boundary and have not affected implementation of the LF004 remedies, nor resulted in increased exposure to contaminants. Fill material for the Port Expansion project was quarried from the Cherry Hill borrow pit, located to the south of and outside the LF004 North soil LUC boundary, LF004 South and WP014. The borrow pit area was designated in the Base General Plan as "open space." Prior to quarrying operations, extensive soil borings were advanced to define the groundwater table at the Cherry Hill borrow pit. Quarrying was conducted to avoid contact with groundwater by leaving a 5-foot buffer zone between the bottom of the excavation and the shallow groundwater table. Borrow pit activities did not result in a significant change in land use or any increased exposure to contaminants. The areas of the

Port Expansion project relative to LF004 and WP014 are illustrated in Figure A-3 (Appendix A).

Table 3-1
Site-Specific Land Use

OU (Site)	Land Use In ROD	Current Land Use[1]	Long-Term Planning[2]
OU1 (LF059)	Outdoor recreation	Open space and buffer zone[4]; LF059 is a restricted use area[3].	No development planned.
OU2 (ST041)	Outdoor recreational and unmanned industrial use only, excluding the development of commercial aquaculture	Listed as manufacturing and production, but land is currently vacant and used for outdoor recreation.	No development planned.
OU4 (FT023) (SD024) (SD025) (SD028) (SD029)	Light industrial, aircraft O&M, and airfield	Airfield use area, aerospace maintenance.	Development plans are for continued airfield uses, similar to current uses.
OU5 (ST037)	Primarily light industrial, but also includes residential, open space, railroad right-of-way, Post Road, picnic area and golf course, and fish hatchery	Primarily light industrial, but also includes residential, open space, railroad right-of-way, Post Road, picnic area and golf course, and fish hatchery.	Industrial warehouses, office/ administrative, residential, and Air National Guard uses; similar to current land uses.
OU6 (LF002) (LF003) (LF004) (SD015) (WP014)	Open space, outdoor recreation, and restricted use	Open space and buffer zone[4]. LF002, LF003, and LF004 are restricted use areas.[3]	No development planned.
(DP098)	Administrative, open space, outdoor recreation, and industrial	Administrative, open space, and buffer zone[4].	No development planned.

Notes:
[1] Based on current land use in Base General Plan and 673d Air Base Wing Instruction 32-7003.
[2] Based on 50-year vision in Base General Plan.
[3] Restricted use areas provide for recreational use and construction of unmanned facilities such as parking lot, storage building, or taxiway, but prohibit construction of any sort of manned facility such as an office building or a residence.
[4] The “buffer zone” is a safety zone around the flightline (i.e. no buildings, bird exclusion, etc.).
For definitions, see the Acronyms and Abbreviations section.

3.1.2 Geology

Glacial and related deposits including terminal moraines, ground moraines, and glacial outwash plains are the dominant regional landforms on JBER-E and in the surrounding area. The most distinctive landform at JBER-E is the Elmendorf Moraine, a southwest-northeast trending terminal moraine. The moraine consists of horizontally and vertically discontinuous, unconsolidated glacial till with poorly sorted boulders, gravel, sand and silt deposits. Clay lens deposits are found throughout the moraine and may result in zones of perched groundwater. The southern boundary of the moraine is visible as a rising bluff line along the north side of JBER-E's east-west runway. Moraine elevations range from 200 to 300 feet above mean sea level (amsl).

Landform features formed by glacial activity can be seen north of the Elmendorf Moraine in the form of drumlins, eskers, kame terraces, and kettle lakes. Elevations in this area range from 125 to 210 feet and gently slope to the east. South of the Elmendorf Moraine lies the glacial outwash plain alluvium. The alluvium deposits were formed by a series of coalescing streams resulting from glacial melt water. These outwash plain deposits consist of unconsolidated fine- to medium-grained, poorly sorted sand and gravel. Elevations range from 100 to 225 feet amsl. Relief is generally flat and gently sloping to the south-southwest. Most of the developed areas on JBER-E are built on the outwash plain alluvium and more than 90 percent of the contaminated sites are located in this area. Underlying glacial moraine and outwash deposits are shallow marine deposits of the Bootlegger Cove Formation. The Bootlegger Cove Formation is a fine-grained glacioestuarine deposit consisting of silt and clay. Depth to the Bootlegger Cove Formation ranges from 1 to 60 feet below ground surface (bgs) near the moraine and from 75 to 100 feet bgs throughout the outwash plain. Overall, the Bootlegger Cove Formation is estimated to be at least 125 feet thick and may be more than 250 feet thick in some locations (USAF, 2008a).

3.1.3 Groundwater

Two principal groundwater aquifers have been identified in the glacial outwash plain alluvium and on the Elmendorf Moraine. These aquifers include a shallow unconfined aquifer (shallow aquifer), and a deeper confined regional aquifer. The Bootlegger Cove Formation acts as the confining layer between the shallow and deep aquifers. In general, groundwater flow direction in the shallow aquifer matches closely that of the surface topography. Groundwater flow is to the northwest along the north limb of the moraine, and to the southeast along the south limb. A local groundwater divide coincides with the crest of the moraine. The shallow aquifer on JBER-E is not used for drinking water.

The deeper confined aquifer is a regional aquifer that underlies all of JBER-E. Groundwater flow direction to the confined aquifer is westerly from the Chugach Mountains toward Knik Arm. Groundwater from the deeper confined aquifer at JBER-E serves only as a standby drinking water supply for when surface water supplies cannot meet the demand. However, the municipal area bordering JBER-E uses groundwater for various services including industrial, commercial, domestic, and public supply.

Groundwater monitoring data show contamination in portions of the shallow aquifer onsite. There is no evidence that contaminant releases from JBER-E have contaminated the deeper, confined aquifer. Groundwater samples were collected from four wells in the deeper confined aquifer during the OU5 RI (USAF, 1994g). The four wells were JBER-E Supply Wells 2 and 52, and offsite water supply wells for two businesses along Post Road, IGM and the Inlet Co. No organic contaminants were detected in any of these wells. As such, the Bootlegger Cove Formation appears to serve as an effective barrier between the aquifers, and there is no evidence that the shallow and deep aquifers are hydraulically connected under JBER-E (USAF, 2008a).

3.1.4 Surface Water

JBER-E has four major drainage basins and a number of natural and man-made lakes and ponds. The major drainage systems include Ship Creek, Six-Mile Creek, EOD Creek, and Cherry Hill Ditch:

- Ship Creek is the largest surface water drainage system on JBER-E (Appendix A, Figure A-1). It originates in the Chugach Mountains to the east, runs along the southern boundary of JBER-E, and empties into the Knik Arm. The upper Ship Creek basin is an important recharge area for the deeper confined aquifer and provides approximately one quarter of total recharge to the system.

- Six-Mile Creek and EOD Creek are located north of the Elmendorf Moraine and more than 1 mile north of any of the CERCLA sites. Six-Mile Creek originates as springs located near the JBER-E and JBER-Richardson boundary. EOD creek consists of 1 mile of stream channel originating from seeps in a bog wetland area.
- Cherry Hill Ditch is the major storm water drainage system for the main base area south of the Elmendorf Moraine.

JBER-E has 12 natural and man-made lakes and ponds varying from one acre to 123 acres in size. Most of these water bodies are located north of the Elmendorf Moraine (USAF, 2008a).

The Knik Arm of the Cook Inlet borders JBER on the west and north for approximately 20 miles. Approximately eight of those shoreline miles border JBER-E. Tidal fluctuations of up to 37 feet create a large, periodic intertidal area that receives limited use by shorebirds but is a heavily used travel corridor for brown bears and wolves. The waters of the Knik Arm in this area are used by the Cook Inlet beluga whale and other marine mammals. However, the property and overlying waters of JBER between Mean Higher High Water and Mean High Water have been excluded from the critical habitat designation for the Cook Inlet beluga whale.

3.2 SITE HISTORY

3.2.1 History of Contamination

JBER-E operations since the mid-1940s have generated varying quantities of hazardous and nonhazardous wastes from industrial and airfield operations, fire training, and fuels management. In August 1990, Elmendorf AFB (now JBER-E) was placed on the NPL, bringing it under the federal facility provisions of CERCLA § 120. To date, the USAF has identified 85 sources of contamination from historic operations that occurred prior to 1984. These sources have been grouped into three divisions: CERCLA sources, state program sources, and other program sources:

- Thirty-eight of the 85 source areas are designated as CERCLA sources. Thirty-four of these have been grouped into six OUs (Table 1-1), and remedial activities are being conducted under the FFA (EPA, 1991). Four other sites: SS022, SS109, DP098, and

SA100, were addressed separately from the OUs. Sixteen of these sites are considered active; all others were designated as requiring NFA at the time of the ROD and were subsequently closed. SS022 is not included in this five-year review because it is currently undergoing a remedial investigation/feasibility (RI/FS) study and a remedy has not yet been selected. The *Remedial Investigation Report* for SS022 is currently undergoing regulatory review. Additionally, SS109 is not included in this five-year review because it is still in the investigative stage. The remaining 14 active CERCLA sites are addressed in this five-year review (LF059, ST041, FT023, SD024, SD025, SD028, SD029, ST037, SD015, LF002, LF003, LF004, WP014, and DP098).

- Forty-two source areas have been designated as state program sources and are being remediated according to State of Alaska regulations. State program source areas are not included in this five-year review.
- The remaining five source areas were initially identified as historical sources but upon further investigation were determined to be Resource, Conservation and Recovery Act sources. These sites were transferred to JBER-E Environmental Compliance Section, and are not included in this five-year review (USAF, 2008b).

3.2.2 Initial Response

Initial response actions, prior to the signing of the ROD(s), were conducted at some OUs; a brief description of these response actions is listed below:

- An asphalt recovery effort was conducted at LF059 (OU1) during the 1995 and 1996 field seasons. Over 10,000 gallons of liquid asphalt were excavated and recycled as part of the State of Alaska cleanup program.
- At ST041 (OU2), an oil/water separator was installed in 1976 to reduce the amount of fuel being discharged to a drainage ditch adjacent to Fairchild Avenue. Monitoring wells were sampled in 1984 and 1988. In 1989 a small dam was placed in a nearby drainage ditch. After the *OU2 Interim Remedial Action ROD* was signed in 1992 (USAF, 1992), a free product and dissolved-phase recovery treatment system was installed at ST041.
- In 1983, storage of waste liquids in a tank at ST020 (OU2) was prohibited. In 1986, about 105,000 gallons of liquid waste were removed from the tank. The source of contamination at ST020 (i.e., the tank, associated piping, and 1,300 cubic yards of contaminated soil) was removed and the soil treated during 1990. The OU2 ROD (USAF, 1995b) recommended NFA for ST020 because soil was remediated to concentrations less than cleanup levels and the source of groundwater contamination was due to upgradient sources.
- During the fall of 1993 and summer of 1994, a response action at SS010 (OU4) removed both liquid asphalt and asphalt-containing soils left over from former asphalt batch operations. More than 100,000 gallons of asphalt were recovered and recycled for reuse on base. In situ bioventing to treat deep unsaturated soils potentially contributing to contaminants in groundwater operated until 2006.

- Removal of the underground storage tank (UST) and contaminated soils in the vicinity of Pump House Building (PL81 South near LF004 South) was completed in 1996 as part of the state cleanup program. The Pump House Building was also removed from service at this time. The former pipeline and valve pit areas associated with PL81 are an adjacent upgradient source area to WP014 and LF004 South (OU6).
- At LF002 (OU6), landfill debris on top of or protruding from the ground surface was removed in October 1996. At that time, a limited soil cover was applied in three areas that had elevated lead contamination in order to mitigate the direct contact exposure pathway.

3.2.3 Basis for Taking Action

Due to past operations, CERCLA hazardous substances have been released at JBER-E that resulted in soil, sediment, surface water, and groundwater contamination in various locations (refer to individual RODs listed in Section 12.0 for more detail). The initial risk assessments in each ROD determined the human and/or ecological risks exceeded the EPA's average or reasonable maximum exposure risk management criteria. Final chemicals of concern (COCs) specified in the RODs for each OU are summarized in Table 3-2.

Table 3-2
Chemicals of Concern

Chemicals	OU1	OU2	OU4	OU5	OU6	DP098
Surface Water						
Benzene		X				
Ethylbenzene		X				
Toluene		X				
Total Aromatic Hydrocarbons				X		
Total Aqueous Hydrocarbons				X		
Sheen				X		
Groundwater						
1,1,1-Trichloroethane			X			
1,1,2-Trichloroethane					X	
1,1,2,2-Tetrachloroethane					X	
1,1-Dichloroethene			X			X
1,2-Dibromoethane	X					

Table 3-2
Chemicals of Concern, (Continued)

Chemicals	OU1	OU2	OU4	OU5	OU6	DP098
1,2-Dichloroethane			X		X	
cis-1,2-Dichloroethene			X			X
Benzene		X	X	X	X	
Ethylbenzene		X	X		X	
Manganese	X					
Methylene Chloride					X	
Tetrachloroethene			X			X
Toluene		X	X		X	
Trichloroethene	X		X	X	X	X
Vinyl Chloride	X					X
Xylenes		X				
Soil						
Benzene, Toluene, Ethylbenzene, and Xylenes (BTEX)					X	
1,1,-Dichloroethene						X
cis-1,2-Dichloroethene						X
Diesel-Range Organics (DRO)			X		X	
Gasoline-Range Organics (GRO)			X		X	
Jet Fuel			X			
Tetrachloroethene						X
Total Fuel Hydrocarbons (TFH) – diesel				X		
Trichloroethene						X
Xylenes			X			
Exposed Landfill Debris					X	
Lead					X	
Sediment						
cis-1,2,-Dichloroethene						X
Trichloroethene						X

Notes:
X indicates whether the contaminant was present at the time of the ROD
For definitions, see the Acronyms and Abbreviations section.

4.0 REMEDIAL ACTIONS

Initial plans, remedial action objectives (RAOs), selected remedy descriptions, remedy implementation history, and current status of the remedies associated with each OU are presented in this section. LUCs (referred to in the OU1, OU2, OU4, OU5, and OU6 RODs as institutional controls) that have been implemented on site are discussed separately in Section 4.7.

4.1 OPERABLE UNIT 1

OU1 is located in the southeastern portion of the base, next to Vandenberg Avenue and immediately north of Ship Creek (Appendix A, Figure A-2). OU1 is currently more than 60 acres in size. In the past, it consisted of five general waste disposal areas designated LF005, LF007, LF013, OT056, and LF059. Various types of material were disposed of, including general refuse, scrap metal, used chemicals, construction debris, and drums of asphalt. Table 2-1 includes a brief chronology of milestone events at OU1.

The OU1 ROD, signed on September 28, 1994 (USAF, 1994), selected a remedial action that included LUCs and groundwater monitoring. A CERCLA *Site Closure Report* documented NFA pursuant to formal closure of LF005, LF007, LF013, and OT056 on July 21, 2004 (USAF, 2004b) because groundwater monitoring results at these sites were consistently below cleanup levels. Four sites in the vicinity of these closed sites with the same names but different boundaries continue to be managed as part of a landfill closure permit under the jurisdiction of the Alaska Solid Waste regulations (18 AAC 60 [ADEC, 2013]).

Only LF059 remains part of OU1 under CERCLA. The LUC remedy component was updated/clarified in memoranda to the site file (USAF, 1997a, 2010e). RAOs were developed to specify actions needed to protect human health and the environment. The RAO, stated as a “goal” in the OU1 ROD (USAF, 1994), is to prevent ingestion/direct contact with groundwater containing contaminants at concentrations in excess of background or EPA maximum contaminant levels (MCL), whichever is greater. Site-specific COCs and their cleanup levels, as defined in the OU1 ROD, are presented in Table 4-1. See the OU1 ROD for more information about exposure routes, receptors, and remediation goals.

Table 4-1
Cleanup Levels at Operable Unit 1

Chemical of Concern	ROD-Established Cleanup Level	Basis for Cleanup Level
Groundwater (µg/L)		
1,2-Dibromoethane	0.05	MCL
Manganese	9,100	Background
Trichloroethene	5.0	MCL
Vinyl Chloride	2.0	MCL

Note:
For definitions, see the Acronyms and Abbreviations section.

The COC 1,2-Dibromoethane is an additive to leaded gasoline. Manganese is a naturally occurring metal in the soil around Anchorage and was the only contaminant consistently observed throughout the OU. Trichloroethene (TCE) and vinyl chloride are solvents most likely present due to past disposal activities.

4.1.1 Operable Unit 1 Remedy Implementation and Status

Implementation of the OU1 ROD components was documented in a remedial action report (USAF, 1998d). The major components of the selected remedy and the current status of each, through 2013 are provided in Table 4-2 and discussed in the text that follows.

Table 4-2
Operable Unit 1 Remedy Implementation Status

Remedy Component	Brief Status
Implement LUCs, which include: • Restrict land use and define areas designated for recreational use. • Enforce base policy prohibiting installation of groundwater wells into the shallow aquifer. • Securing of existing water supply and groundwater monitoring wells LUCs will be managed and implemented in accordance with the 2010 *LUC Memorandum to the Site File for Operable Units (OUs) 1, 2, 4, and 5* (USAF, 2010e). Additionally, the LUC boundaries are depicted in Figure 4.1 of the 2010 *LUC Memorandum to the Site File for Operable Units (OUs) 1, 2, 4, and 5* (USAF, 2010e)	Implemented March 1994. Details on LUC implementation are clarified in Memoranda to the Site File in 1997 and 2010, and the May 2011 673d Air Base Wing Instruction 32-7003 Land Use Control Management. No LUC breaches were identified during the period under review.
Monitor groundwater for five years, or until the groundwater no longer poses an unacceptable health risk.	Cleanup levels were met for 1,2-dibromoethane in 1996, vinyl chloride in 1997, and manganese in 2001. Groundwater cleanup levels for all COCs were met at LF005, LF007, LF013 and OT056, leading to the removal of these sites from CERCLA in 2004. Monitoring is ongoing at LF059, where only TCE remains above the cleanup level.
Five-year review to assess the protectiveness of the remedial action.	Ongoing (1998, 2003, 2008, and 2013).
Periodic evaluation of monitoring results to determine if there is a need for further remedial action.	Ongoing for LF059.

Note:
For definitions, see the Acronyms and Abbreviations section.

All remedial actions are operational and functional at OU1. The status of the active remedy components through 2013 is provided below. LUCs (see Section 4.7) have been established (USAF, 1997a, 1998d) and are being maintained to prevent exposure until cleanup levels are attained. Annual LUC inspections and site visits performed during the five-year review process ensure that the implemented LUCs are in place and effective. Details regarding implementation of LUCs at OU1 are clarified in the memoranda to the site file in 1997 and 2010 and in the Base General Plan. The 2011 673d Air Base Wing Instruction 32-7003 May 19, 2011 (USAF, 2011a) defines how JBER will manage the LUC process. Following the establishment of JBER in 2010, the 673d Air Base Wing Instruction 32-7003 (May 19, 2011 [USAF, 2011a]) was revised to include LUCs from both installations to ensure consistency regarding the implementation of LUCs and to define management and compliance responsibilities.

Since 2003, groundwater monitoring at LF059 has focused on annual monitoring of two wells (LF59MW-02 and LF59MW-03) for volatile organic compounds (VOC). As recommended in the *Third Five-Year Review Report* (USAF, 2008a), compliance monitoring results from upgradient wells at former LF007 were considered when evaluating the effectiveness of the remedy at LF059. Figure C-1 in Appendix A presents the historical concentrations of COCs at LF059 wells.

Groundwater monitoring results are evaluated annually, including trend analysis of COCs and assessment of natural attenuation parameters. Historical data concerning the number of wells sampled annually at OU1 are provided in Appendix H. TCE is the only groundwater COC that remains above the cleanup level. The most recent data (USAF, 2013) show that the remedy is performing as envisioned in the ROD, albeit more slowly. Natural attenuation parameters measured in the field (conductivity, dissolved oxygen, and oxidation-reduction potential) indicate that geochemical conditions at LF59MW-02 and LF59MW-03 fluctuate between weakly reducing and weakly oxidizing; significant reductive dechlorination is unlikely to occur under these conditions. The most recent assessment of the performance of the natural attenuation remedy for OU1 LF059 can be found in the *2011 Zones 1, 2, and 3 Annual Report* (USAF 2012b). Although Mann-Kendall trend analysis at the source area indicates no identifiable trend in TCE concentrations, plume boundaries appear stable (Appendix G).

As discussed previously, LF005, LF007, LF013 and OT056 were closed under CERCLA in 2004 (USAF, 2004b), when the sites were transferred to the JBER-E Compliance Program, which conducts activities necessary to manage former landfills such as erosion control and groundwater sampling as required by 18 Alaska Administrative Code (AAC) 60. Under the Compliance program, former OU1 sites LF005, LF007, and LF013 were capped with evapotranspiration covers in 2005 through 2007 to comply with Alaska Solid Waste Management regulations (18 AAC 60 [ADEC, 2013]). These caps were designed to prevent storm water infiltration into the landfills, limiting leachate migration to groundwater. During the Compliance program's routine groundwater monitoring at wells LF05GW-2B and OU1LF-19 in 2006, elevated levels of TCE were observed (Appendix C, Figure C-1). Consequently, the Compliance program commissioned a characterization study to determine the nature and extent of the groundwater contamination; the study was performed in 2006 (USAF, 2007a). The study identified two chlorinated solvent plumes; however, only one appears to affect LF059 – the TCE plume that appears to originate at or near LF007 and may be the source of TCE contamination at LF059.

While the cause of the increased TCE concentrations downgradient of the landfill area is unknown, it is suspected that the evapotranspiration landfill covers may be causing changes to the hydraulics of the area. The full impact of the covers may not be realized until the plants reach maturity, which is predicted to occur approximately seven years after cap construction/planting (approximately 2013 for LF007). Quarterly monitoring at LF05GW-2B and OU1LF-19 has occurred under the Compliance program (Appendix C, Figure C-1). TCE concentrations at LF05GW-2B have fluctuated slightly near the cleanup level since 2008. Concentrations of TCE have exceeded the cleanup level at monitoring well OU1LF-19 since 2006, with exception of the fourth quarter 2011 sampling event. Mann-Kendall trend analysis indicates no identifiable trend in TCE concentrations at LF05GW-2B; however, a decreasing trend was identified for monitoring well OU1LF-19.

4.1.2 Operable Unit 1 System Operations and Maintenance

Annual system operations and maintenance (O&M) costs include planning and management, sampling, monitoring, reporting, and five-year reviews. Annual LUC management costs include site inspections, photographic documentation, and reporting. In the ROD, annual costs for the OU1 remedy were estimated to be $48,000 per year (USAF, 1994a). Monitoring costs for OU1 were originally greater than predicted in the ROD but decreased dramatically after 2002, due primarily to the elimination of CERCLA monitoring at all OU1 sites except for LF059. With the exception of 2008, the annual monitoring costs at OU1 have continued to decrease. Historical O&M costs associated with OU1 are provided in Appendix H.

4.2 OPERABLE UNIT 2

OU2 consists of two source areas, ST020 and ST041, located in the central and western portion of the base, respectively (USAF, 1995b). Briefly described:

- ST020 is the former site of a 338,000-gallon UST that was used to store Bunker C fuel oil, waste oils, used solvents, and other wastes. The tank, associated piping, and contaminated soils at ST020 were removed in 1990, which resulted in a NFA determination in the OU2 ROD (see Section 3.2.2, Bullet #3). ST020 is not included in this five-year review.
- ST041 (Appendix A, Figure A-2) is the former site of four 1-million-gallon USTs. An interim remedial action ROD was signed September 1, 1992 (USAF, 1992), resulting in the design, installation and operation of a free-product and dissolved-phase recovery and treatment system at ST041 beginning in October 1993. The free-product recovery system met its requirements and was shut down in 1999 (USAF, 1999a).

The OU2 ROD was signed on May 19, 1995 (USAF, 1995b) and included source removal (tanks, piping and contaminated soil), continued operation of the free-product recovery system, groundwater and surface water monitoring to assess natural attenuation, and LUCs to prevent access to contaminated groundwater and soils at ST041. The COCs for both groundwater and surface water are fuel-related chemicals that are attributed to past operations and/or spills associated with the USTs. Following the establishment of JBER in 2010, the 673d Air Base Wing Instruction, 32-7003, May 19, 2011 USAF, 2011a) was revised to include LUCs from both installations to ensure consistency regarding the implementation of LUCs and to define management and compliance responsibilities. A brief chronology of events occurring at OU2 has been provided in Table 2-1.

RAOs were developed in the OU2 ROD to specify actions needed to protect human health and the environment (USAF, 1995b). The RAOs define the COCs as listed in Table 4-3, exposure routes and receptors, and remediation goals, which are defined as an acceptable contaminant level for each exposure route. RAOs specified in the OU2 ROD are as follows:

- Prevent ingestion and contact with groundwater containing contaminants in concentrations in excess of background or MCLs, whichever is greater;
- Prevent use of groundwater for aquaculture, or if aquaculture use is proposed in the future, treat water to an acceptable level;
- Prevent contaminated seep water (surface water) from entering wetlands;
- Reduce further migration of contaminants due to free-phase product currently at the water table and of any residual product that may exist in piping and underground tanks;
- Prevent migration of contaminants found in soil that would result in groundwater contamination in excess of MCLs or health-based levels;
- Attain residual contaminant levels which would restore groundwater as a potential source of drinking water; and
- Compliance with all action-, chemical-, and location-specific applicable or relevant and appropriate requirements (ARARs).

Final remediation goals for groundwater include preventing ingestion or direct contact with groundwater containing contaminants with concentrations in excess of background levels or federal drinking water standards (primary MCLs, 40 CFR 141), as shown in Table 4-3. Final remediation goals for surface water include compliance with location- and chemical- specific ARARs. The location-specific goal is avoidance of long-term and short-term adverse impacts associated with destruction or modification of the wetlands area.

The chemical-specific cleanup levels include compliance with State of Alaska surface water quality criteria (SWQC) as established in 18 AAC 70, which are based on total aromatic hydrocarbons (TAH) for surface water COCs benzene, ethylbenzene, and toluene.

Table 4-3
Cleanup Levels at Operable Unit 2

Chemical of Concern	ROD-Established Cleanup Level	Basis for Cleanup Level
Groundwater (µg/L)		
Benzene	5	MCL
Ethylbenzene	700	MCL
Toluene	1,000	MCL
Xylenes	10,000	MCL
Surface Water (µg/L)		
Benzene	10*	18 AAC 70
Ethylbenzene	10*	18 AAC 70
Toluene	10*	18 AAC 70

Notes:
µg/L = micrograms per liter
* = The established cleanup level is the sum of benzene, ethylbenzene, and toluene concentrations.
For additional definitions, see the Acronyms and Abbreviations section.

During development of the 2002 monitoring plan, ADEC comments, and response from the USAF, resulted in the understanding that the 10 µg/L cleanup standard applies to the sum of the benzene, ethylbenzene, and toluene concentrations. The *Second Five-Year Review Report* (USAF, 2003a) recommended that OU2 surface water at the point of compliance be monitored for TAH and Total Aqueous Hydrocarbons (TAqH). The *Five-Year Review Report* (USAF, 2008a) recommended that OU2 surface water at the point of compliance (SW-13) be sampled only for TAH annually.

4.2.1 Operable Unit 2 Remedy Implementation and Status

The major components of the selected remedy and the current status of each, through 2013, are provided in Table 4-4 and the text below.

Table 4-4
Operable Unit 2 Remedy Implementation Status

Remedy Component	Brief Status
Groundwater	
Continuing the operation of the interim remedial action free-product recovery system until all practicable free product has been recovered to mitigate the continuing source of contamination.	The recovery system met the requirements and was shut down in April 1999.
Continue seep mitigation until performance criteria outlined in the ROD or a later governing document (i.e., memorandum to the site file) are met. Samples will be collected once every five years from seep water (ST41SP-01) to track the progress of natural attenuation. In addition, long-term monitoring must show that natural attenuation will continue to be protective of the wetlands in the area, which will be demonstrated by collected annual surface water samples at the point of compliance (ST41SW-13).	The recovery system met the requirements at the surface water points of compliance and was shut down in April 1999. Seep and wetland monitoring is ongoing to ensure protection.
Monitoring the groundwater beneath and adjacent to the site to evaluate contaminant migration and timely reduction of contaminant concentrations by natural attenuation within 21 years. This will include five-year reviews to assess the protectiveness of the remedial action as long as contamination remains above acceptable levels. Groundwater monitoring will be conducted in accordance with the long-term monitoring plan schedule set forth in the Remedial Design/Remedial Action Statement of Work.	Monitoring has been ongoing since 1996. The monitoring plan is reviewed annually to ensure the program remains comprehensive and protective.
Maintain LUCs that restrict access to groundwater and groundwater development at the site. The specific institutional controls (now known as LUCs) implemented and/or maintained at OU2 are as follows: • Designate the affected area for outdoor/recreational use and unmanned industrial use, excluding the development of commercial aquaculture; • Continue enforcement of base policy prohibiting installation of groundwater wells (other than for monitoring purposes) into the shallow aquifer underlying OU2; and • Prohibit unauthorized access to existing water supply and groundwater monitoring wells.	Implemented in March 1995 and ongoing. Land use designations were updated in the *Remedial Action Report* in 1998 (USAF, 1998b). LUCs updated in 2007 and 2010, and the May 2011 673d Air Base Wing Instruction 32-7003 *Land Use Control Management*. No LUC breaches were identified during the period under review.

Table 4-4
Operable Unit 2 Remedy Implementation Status (Continued)

Remedy Component	Brief Status
LUCs will be managed and implemented in accordance with the *2010 LUC Memorandum to the Site File for Operable Units (OUs) 1, 2, 4, and 5* (USAF, 2010e). Additionally, the LUC boundaries are depicted in Figure 4.2 of the 2010 *LUC Memorandum to the Site File for Operable Units (OUs) 1, 2, 4, and 5* (USAF, 2010e).	
In addition, to ensure long-term integrity of the above LUCs, USAF will ensure that, to the extent that groundwater remains above acceptable levels, deed restrictions or equivalent safeguards will be implemented in the event that property containing such contamination is transferred by USAF. The measures taken will include: • Five-year review to assess the protectiveness of the remedial action; and • Periodic evaluation of monitoring results to determine if there is a need for further remedial action.	Implemented in March 1995 and ongoing. Five-year reviews have been conducted in 1998, 2003, 2008, and 2013.
Source Control	
Cleaning of the four 1-million-gallon USTs, disposal of the residual sludge according to applicable statutes, and filling them with inert material.	Completed in September 1996.
Excavating, removing, and disposal/recycling of the piping system.	Completed in September 1996.
Removing contaminated soil associated with piping that contains leachable concentrations of fuel-related contaminants, and offsite disposal and thermal treatment of those soils.	Completed in September 1996.
Re-vegetating the area.	Completed in September 1996.

Note:
For definitions, see the Acronyms and Abbreviations section.

In addition to the remedies outlined in Table 4-4, the OU2 ROD contained a contingent remedy for groundwater. The contingent remedy for ST041 groundwater includes the following major components:

- Extracting groundwater from the shallow aquifer to eliminate further migration;

- Treating the extracted water with an air stripping process to meet federal, state and local water quality regulations;
- Treating the air emissions from the air stripping process to meet state and base air emission permit requirements;
- Disposing of the treated groundwater in accordance with federal, state, and local regulations and permit requirements;
- Five-year review to assess the protectiveness of the remedial action; and
- Monitoring of the effectiveness of the groundwater containment and treatment process until the benzene concentrations reach the MCL or groundwater no longer poses an unacceptable health risk (USAF, 1995b).

The contingent remedy will be implemented if the USAF, in consultation with the EPA and ADEC, evaluate the effectiveness of the selected remedy and determine:

- Long-term monitoring of groundwater at ST041 indicates that natural attenuation is not occurring at an acceptable rate such that concentrations of contaminants will not meet regulatory standards within an acceptable period of time. An estimated timeframe of 21 years will be used to evaluate natural attenuation.

Both plumes continue to exhibit a decreasing trend in contaminant concentrations and the contingent remedy has not been implemented; however based on current concentrations, RAOs will not be met within the 21-year timeframe specified in the ROD (by 2016). The free-product and dissolved-phase recovery and treatment system portion of the remedy began operation in October 1993 and operated until April 1999. The system removed approximately 145 gallons of product as of November 1994. Only small quantities of free product were recovered through 1996, and no recoverable free product was observed from February 1997 to February 1999 (USAF, 1999a, 1999b). Hand-bailing methods are used to recover remaining small quantities of floating free product at wells with more than 0.1 foot free-product thickness. Free-product thickness, when detected at all, has been less than 0.1 foot since 2003 with the exception of 2009, when free-product thickness measured 0.15 feet in the South Plume (USAF, 2012b). In accordance with the decision guide for monitoring well sampling frequency at OU2, provided in the 2011 *Memorandum to the Site File: Operable Unit 2,* wells with historical free-product are monitored annually for free-product occurrence (USAF, 2011e).

Operation of the interim remedial action system for mitigation of contaminated seeps was clarified in the remedial action report (USAF, 1998b). One of the conditions for shutting down the treatment system was to demonstrate protectiveness of surface water (wetlands) or seeps. The endpoint for shutting down the treatment system was not established in the ROD, but was subsequently defined in a technical evaluation of the ST041 treatment system (USAF, 1997b). The endpoint was defined as contaminant concentrations in surface water below SWQC at point of compliance locations for one year with the system operating, and an additional year with the system shut off. The point of compliance was defined as sampling location ST41SW-13, located on the north side in the wetland area (USAF, 1999a). Contaminant concentrations at points of compliance were below the SWQC in 1997 (USAF, 1998b). Since 2003, sampling has been conducted at one seep (ST41SP-01) and one surface water sampling location (ST41SW-01), but these locations are considerably upgradient of the point of compliance ST41SW-13. Due to confusion over its location, ST41SW-13 was not sampled again until 2008. ST41-SW13 has been sampled annually since that time and contaminant concentrations have consistently remained below the SWQC (USAF, 2013). To reduce the confusion over the location and sampling schedule for the point of compliance (ST41-SW13) and the associated seep (ST41-SP01), a 2011 memorandum to the site file (USAF, 2011e) was signed by the USAF, EPA, and ADEC.

Groundwater and surface water monitoring at OU2 has been conducted at least annually since the interim remedial action. Groundwater monitoring plans are reviewed annually to ensure the program remains comprehensive and protective. Current monitoring requirements at ST041 include periodic groundwater, seep, and surface water sampling and an annual LUC inspection. Historical data concerning the number of wells/seeps/surface water points sampled annually at OU2 are provided in Appendix H.

Groundwater sampling is required for the COCs listed in Table 4-3 at groundwater monitoring wells ST41-16 (annual), ST41-25 (annual), ST41-10R (every 2 or 3 years), ST41-20 (every five years), ST41-28 (annual), ST41-30 (every five years), and ST41-34 (every five years). Seep ST41SP-01 is required to be sampled for site COCs every five years and surface water location ST41SW-13 annually. ST41-08 was sampled once in 2009 and additional sampling is not planned at this time. LUCs are in place to prevent access and exposure to contaminated groundwater and soil at the site (USAF, 2013).

Groundwater and surface water samples that are collected in a given year are evaluated annually and include a trend analysis of COCs and assessment of natural attenuation parameters. Recommendations are then provided in an annual report based on the results of this evaluation. Figure C-2 in Appendix C presents COC concentrations over time for key wells and surface water locations in OU2. Performance of the natural attenuation remedy for OU2 groundwater and seeps was most recently assessed in 2011 (USAF, 2012b).

Of groundwater COCs, benzene concentrations remain above the cleanup level in most wells sampled in 2012; COCs in downgradient well ST41-25 (South Plume) were not detected or were present below cleanup levels for the first time, and benzene, ethylbenzene, and toluene were detected above cleanup levels in ST41-16 (USAF, 2012). Concentrations of COCs are decreasing in groundwater, indicating that natural attenuation is occurring. Although contaminant concentrations have generally declined, benzene, ethylbenzene and toluene concentrations are still well above the cleanup levels at ST041 plumes. Current trends indicate that COCs are likely to remain above the cleanup level at some wells considerably longer than the ROD-predicted cleanup date of 2016.

Seep (at ST41SP-01) and surface water (at ST41SW-01) samples contain concentrations of benzene above the OU2 cleanup level. Contaminant concentrations at surface water (wetland) sampling location ST41SW-01, located just below the seep ST41SP-01, are nearly as high as those collected from the seep. The point of compliance for the wetland to the north of ST041 was identified as ST41SW-13; it is located at the center of the surface water body located downgradient of the seep (nearly 200 feet downgradient of surface water sample location ST41SW-01). ST41SW-13 was sampled at least five times between 1995 and 2000, but due to confusion over its location, surface water at ST41SW-13 was not sampled during 2003 through 2007 (USAF, 2008a). ST41SW-13 was sampled in 2008 and annually, thereafter, and all contaminants remain below OU2 cleanup levels. Groundwater and surface water trends are evaluated in more detail in Section 6.4.2.

LUCs were implemented in 1995 (USAF, 1998b) and are described in more detail in Section 4.7 (USAF, 2008a). OU2 land use is designated as industrial use only, excluding the development of commercial aquaculture. However, vacant land at OU2 is sometimes used for outdoor recreation (Table 3-1). The *OU2 Remedial Action Report* (USAF, 1998b) documents that the agencies agreed to interpret the ROD as allowing for outdoor/recreational use and unmanned industrial use. UST decommissioning and removal of piping and contaminated soil remedies were implemented, completed, and documented in 1996 (USAF, 1996a, 1998b).

4.2.2 Operable Unit 2 System Operations and Maintenance

Annual system O&M costs include planning and management, operation and maintenance of the free-product recovery system (through 1999), sampling, monitoring, reporting, and five-year reviews. Annual LUC management costs include site inspections, photographic documentation, and reporting. O&M costs were estimated at $27,500 per year for the free-product recovery system (USAF, 1992) and $79,000 per year for the natural attenuation remedy for groundwater (USAF, 1995b). Operational costs of the free-product recovery system were much greater than estimated in the ROD, but this system was shut down in 1999 and its costs were eliminated (USAF, 2008a). Initial monitoring costs appear to have been accurately estimated in the ROD, and these costs have decreased over time due to optimization. Historical O&M costs associated with OU2 are provided in Appendix H.

4.3 OPERABLE UNIT 4

OU4 is located in the central portion of JBER-E, near the main runways, and is divided into OU4 East and OU4 West areas. OU4 covers an area of approximately 360 acres (Appendix A, Figure A-2). Floor drains in eight maintenance buildings (SS018 and SD024 through SD030), a fire training area (FT023), and an asphalt drum storage and processing area (SS010) were the primary sources of contamination at OU4. Contamination included fuel spills, leaking asphalt storage drums, leaking fuel distribution systems and USTs, aircraft refueling operations, aircraft maintenance activities within hangar facilities, and incomplete combustion of fire training materials in the fire training area. Table 2-1 summarizes a brief chronology of milestone events at OU4.

Due to minimal soil contamination, sites SS018, SD026, SD027, and SD030 were designated as NFA for soil in decision documents signed in May 1993 (USAF, 1993a, 1993b, 1993c, 1993d). In 1993 and 1994 (prior to the OU4 ROD), a response action at SS010 removed both liquid asphalt and asphalt-containing soils left over from former asphalt batch plant operations. More than 100,000 gallons of asphalt were recovered and recycled for re-use on base. The remaining source areas, included in the 1995 OU4 ROD, were SS010, FT023, SD024, SD025, SD028, and SD029 (USAF, 1995a).

The OU4 ROD, signed on October 10, 1995 (USAF, 1995b), selected a remedial action that included bioventing and LUCs for subsurface soil contamination, and natural attenuation and LUCs for groundwater contamination. Minor modifications to the ROD were documented as memoranda to the site file, through which a sampling frequency decision guide was established in 2003 (USAF, 2003b), and corrected the cleanup values that had been previously listed in error (USAF, 2010e). The decision guides are presented in Appendix F, Figure F-1. Following the establishment of JBER in 2010, the 673d Air Base Wing Instruction, 32-7003, May 19, 2011 (USAF, 2011a) was revised to include LUCs from both installations to ensure consistency regarding the implementation of LUCs and to define management and compliance responsibilities.

RAOs were developed to specify actions needed to protect human health and the environment. RAOs specified in the OU4 ROD that are applicable to all contaminated groundwater and soil areas include:

- Protect human health and the environment by preventing ingestion of and contact with contaminated media by people;
- Protect uncontaminated media by preventing releases from sources;
- Use treatment techniques whenever practicable; and
- Implement a cost-effective solution that can achieve the cleanup levels for the final COCs.

The RAOs define the site-specific COCs as listed in Table 4-5, exposure routes and receptors, and remediation goals, which are defined as acceptable contaminant levels for each exposure route. The COCs and cleanup levels to be achieved as outlined in the OU4 ROD (USAF, 1995a) are summarized in Table 4-5.

Table 4-5
Cleanup Levels at Operable Unit 4

Location	Chemical of Concern	ROD-Established Cleanup Level	Basis for Cleanup Level[1, 2]
Groundwater (µg/L)			
FT023	1,1,1-Trichloroethane	200	MCL
	1,1-Dichloroethene	7	MCL
	1,2-Dichloroethane	5*	MCL
	Tetrachloroethene	5*	MCL
	Trichloroethene	5*	MCL
	cis-1,2-Dichloroethene	70	MCL
	Benzene	5	MCL
SD025	Benzene	5	MCL
	Ethylbenzene	700	MCL
	Toluene	1,000	MCL
SD024, SD026, SD027	Benzene	5	MCL
SD028, SD029	Tetrachloroethene	5	MCL
	Trichloroethene	5	MCL
Soil (mg/kg)[3]			
FT023	Diesel-Range Organics	2,000	ACM
	Gasoline-Range Organics	1,000	ACM
SD024, SD025	Diesel-Range Organics	2,000*	ACM
	Gasoline-Range Organics	1,000*	ACM
SS010	Diesel-Range Organics	2,000	ACM
	Jet Fuel	2,000	ACM
	Xylene	100	ACM
	Gasoline-Range Organics	1,000	ACM

Notes:
*The cleanup levels for 1,2-dichloroethane, tetrachloroethene, and trichloroethene in groundwater at FT023, and DRO and GRO in soil at SD024 and SD025, as presented in OU4 ROD, were inconsistent with their referenced standards. The cleanup levels here reflect the corrected values established in the USAF Memorandum to the Site File, Elmendorf Air Force Base, dated January 25, 2010.
[1] MCLs correspond to the values listed in 40 CFR § 131, and 18 AAC Chapter 70.010a and d, 70.015 through 70.011, and 18 AAC 80.070
[2] ACM refers to the Alaska Cleanup Matrix Level D, promulgated under 18 AAC 78.315.
[3] There are no soil cleanup levels for soil at SD026, SD027, SD028, and SD029 They are not listed because contaminant levels were below regulatory standards at the time of the ROD.
For definitions, see the Acronyms and Abbreviations section.

4.3.1 Operable Unit 4 Remedy Implementation and Status

The major components of the selected remedy for OU4 include bioventing and LUCs for subsurface soil contamination, and natural attenuation and LUCs for groundwater contamination. The major components of the selected remedy and the current status of each, through 2013, are provided in Table 4-6 and the text that follows.

Table 4-6
Operable Unit 4 Remedy Implementation Status

Remedy Component	Brief Status
Groundwater	
Institutional controls (also known as LUCs) on land use and water use restrictions will restrict access to the contaminated groundwater throughout OU4 until cleanup levels have been achieved. OU4 is designated "Airfield Use Area" for aircraft O&M, to include active and inactive runways, taxiways, and parking aprons for aircraft. LUCs will be managed and implemented in accordance with the 2010 *LUC Memorandum to the Site File for Operable Units (OUs) 1, 2, 4, and 5* (USAF, 2010e). Additionally, the LUC boundaries are depicted in Figures 4.3 and 4.4 of the 2010 *LUC Memorandum to the Site File for Operable Units (OUs) 1, 2, 4, and 5* (USAF, 2010e)	Implemented June 1998. LUCs updated in memoranda to the site file 2007 and 2010, and May 2011 673d Air Base Wing Instruction 32-7003 *Land Use Control Management*. No LUC breaches were identified during the period under review.
Groundwater will be monitored and evaluated in accordance with the *Basewide Monitoring Program Well Sampling Frequency Decision Guide* to assess contaminant migration and timely reduction of contaminant concentrations by intrinsic remediation (i.e., natural attenuation). This will include five-year reviews to assess the protectiveness of the remedial action, as long as contamination remains above cleanup levels. A monitoring plan will be prepared to address the details involved in sampling.	Ongoing since 1996. The *Well Sampling Frequency Decision Guide* was used to establish a monitoring schedule in 2003. Five-year reviews were conducted in 1998, 2003, 2008, and 2013. With the exception of SD025, COC concentrations are generally decreasing at all sites. Concentrations of COCs at SD025 exhibit either no trend or are increasing; therefore, no cleanup date can be predicted. Concentrations of TCE appear to decreasing at SD029; however, they remain slightly above the cleanup level. Concentrations of COCs at SD024 and SD028 are below cleanup levels.

Table 4-6
Operable Unit 4 Remedy Implementation Status (Continued)

Remedy Component	Brief Status
Soil	
Institutional controls on land use (also known as LUCs) will continue to restrict access to the contaminated shallow soils throughout OU4 until cleanup levels have been achieved. Details for implementing LUCs are provided in Section 4.1 of the 2010 *LUC Memorandum to the Site File for Operable Units (OUs) 1, 2, 4, and 5* (USAF, 2010e).	Implemented June 1998. All shallow soils in OU4 met cleanup levels as of 1998.
Deep soils at the fire training area (FT023), the asphalt drum storage area (SS010), and Hangar 11 (SD025) will be treated with bioventing to accelerate degradation of contaminants in those locations. Deep soils at other source areas will be allowed to degrade through intrinsic remediation.	FT023, SS010, and SD025 have reached cleanup levels and bioventing systems were shut down in 2009, 2006, and 2003, respectively.
Both shallow and deep soils will be monitored bi-annually to evaluate contaminant migration and timely reduction of contaminant concentrations by intrinsic remediation (i.e., natural attenuation). If cleanup levels are not being achieved further remedial action will be evaluated. This will include five-year reviews to assess the protectiveness of the remedial action, as long as contamination remains above cleanup levels.	Soils have reached cleanup levels at all sites. Five-year reviews were conducted in 1998, 2003, 2008, and 2013.
When concentrations in the bioventing areas are below cleanup levels, bioventing will be discontinued. A monitoring plan will be prepared to address the details involved in sampling.	Closure sampling conducted for SD025 in 2002, SS010 in 2003, and FT023 in 2009. All three bioventing systems have been shut down.
All soils are expected to be cleaned up within eleven years (2006).	Soils meet cleanup levels at all sites.

Note:
For definitions, see the Acronyms and Abbreviations section.

All remedial actions were implemented as of 1998 (USAF, 1998g). Soil and groundwater LUCs (see Section 4.7) were established and are maintained to prevent exposure until cleanup levels are attained. Cleanup levels have been attained for deep and shallow soils at all OU4 sites (USAF, 1998g).

Bioventing systems were installed and activated at FT023, SS010, and SD025 in November 1995 (USAF, 1998g). The system at FT023 was shut down in June 2009 so that subsurface soil samples could be collected (USAF, 2012b). Results indicated that diesel-range organics (DRO) concentrations were below cleanup levels and the soil remedy at FT023 was complete. Most of the components of the bioventing system were decommissioned in October 2009 and final decommissioning was completed in December 2010 (USAF, 2012b). Closure soil sampling conducted at SD025 in 2002 demonstrated that cleanup objectives were achieved for all soil contaminants. Based on these data, the SD025 bioventing system was shut down in 2003 (USAF, 2003f). Although SD025 soils meet cleanup levels, SD025 is still an open site due to the presence of contaminants in groundwater above the cleanup levels. Closure soil sampling conducted at SS010 in 2003 demonstrated that cleanup objectives were achieved for all soil contaminants. Based on these data, the SS010 bioventing system was shut down in 2006, and a NFA determination was achieved pursuant to formal closure of SS010 (USAF, 2006b).

Groundwater monitoring is ongoing at OU4, and groundwater monitoring plans are updated annually to ensure that the program remains comprehensive and protective. Historical data concerning the number of wells sampled annually at OU4 are provided in Appendix H. Appendix C, Figures C-3 through C-7 present the historical concentrations of selected COCs found at key wells in OU4, where groundwater is monitored annually (FT023, SD024, SD025, and SD029). Groundwater results at OU4 sites SS010, SS018, SD026, SD027, and SD030 have achieved cleanup levels, and are now closed.

Groundwater monitoring results have been evaluated annually since the previous *Five-Year Review Report* (USAF, 2008). Evaluations included trend analysis of COCs (Appendix G) and an assessment of natural attenuation parameters. COC concentrations in groundwater are below cleanup levels at the FT023 North Plume, SD024, and SD028. Concentrations of TCE remain slightly above the established cleanup level at SD029; however a decreasing trend has been identified for the site. Natural attenuation processes appear to be working at these sites. However, natural attenuation processes do not appear to be occurring effectively at SD025, where concentrations of COCs remain above cleanup levels and an increasing trend has been identified for at least one COC (ethylbenzene); for this reason, a cleanup date cannot be predicted for this site. Contaminant concentration data will be discussed in more detail in Section 6.4.3.

The 2003 five-year review indicated that it was unclear whether natural attenuation of chlorinated solvents would be limited by the amount of organic carbon available at the FT023 South Plume. The 2008 five-year review (USAF, 2008a) concluded that benzene, toluene, ethylbenzene, and xylenes (BTEX) concentrations were sufficiently high to support reductive dechlorination, and that chlorinated solvents were expected to meet cleanup levels by 2010. However, samples collected from the in-source well (OU4MW-11) at the FT023 South Plume in 2012 continued to exhibit concentrations of tetrachloroethene (PCE), TCE, and cis 1,2-DCE which exceeded applicable cleanup levels (USAF, 2013). Current trend analysis shows that TCE concentrations are decreasing in the source well (OU4MW-11) at the FT023 South Plume; however, a cleanup date cannot be predicted at this time.

4.3.2 Operable Unit 4 System Operations and Maintenance

FT023 bioventing system O&M procedures are specified in the O&M manual (USAF, 1996d), and included biweekly maintenance and system checks to inspect bioventing wells, blower units, and piping; annual in situ respiration testing; soil gas checks to ensure bioventing sites are well oxygenated; and evaluation of contaminant trends (USAF, 2008a). Performance of O&M activities are documented in various annual reports. The bioventing system was shut down in June 2009 to allow for sampling of subsurface soil. Based on sampling results which indicated that DRO concentrations were below the cleanup level, most of the FT023 bioventing system was decommissioned in October 2009 and final decommissioning was completed in December 2010 (USAF, 2012b).

Annual system O&M costs for this system included planning and management, operation and maintenance of the bioventing systems, sampling, monitoring, LUC management, reporting, and five-year reviews. In the ROD, annual costs for the OU4 remedy were initially estimated to be $173,000 per year ($50,000 for groundwater monitoring and LUCs, $32,000 for soil monitoring and LUCs, and $91,000 for bioventing operations), but were expected to decrease over time as sites reached cleanup goals. The ROD estimated that by 2003, O&M costs would be reduced to $65,000 per year ($37,000 for groundwater monitoring and LUCs, $11,000 for soil monitoring and LUCs, and $27,000 for bioventing operations); and by 2007, O&M costs would further decrease to $27,000 per year (groundwater monitoring and LUCs only). With the exception of 2010 through 2012, the O&M costs are reasonably close to ROD estimates for individual remedy components (USAF, 2008a). However, because cleanup objectives have not been met as quickly as estimated in the ROD, O&M costs have not decreased as predicted. Current O&M costs include monitoring at four source areas. Annual LUC management costs include site inspections, photographic documentation, and reporting. Historical O&M costs associated with OU4 are provided in Appendix H.

4.4 OPERABLE UNIT 5

OU5 is located along the southern boundary of JBER-E and covers an area of about 200 acres (Appendix A, Figure A-2). Groundwater generally flows south from the flight line and industrial areas of the base through OU5. Some groundwater discharges in seeps along a steep bluff in the western part of the OU, or into a wetland area where there are several shallow connected water bodies and marshes in the eastern part of the OU. Bulk storage of diesel fuel, jet fuel and multi-product fuel pipelines were initially the primary source of contamination within OU5. Chlorinated solvents from sources south of the east-west runway are the significant sources of groundwater contamination in OU5. Any contaminants migrating toward Ship Creek via groundwater and seep/surface water are being treated through OU5 remedial actions (USAF, 2008a). Table 2-1 includes a brief chronology of milestone events at OU5.

Due to minimal soil contamination, ST038, SD040, SS042, ST046, and SS053 were granted NFA statuses and decision documents were signed in August 1994 (USAF, 1994d [ST038 and

SD42], 1994b [SD040 and SD46], and 1994c [SS053]). ST037 is the only remaining source area within OU5 (USAF, 2008a).

The OU5 ROD, signed on February 1, 1995 (USAF, 1995c), selected a remedial action that included LUCs, natural attenuation of contaminants in groundwater, construction and operation of an engineered wetland remediation system to treat contaminated seeps on the western and central bluffs, natural attenuation for the Beaver Pond wetland area, and contaminated soil excavation and treatment. Minor modifications to the ROD remedy have been documented in memoranda to the site file. The first memorandum to the site file (USAF, 2003b) adopted a sampling frequency decision guide. The decision guide is presented in Appendix F, Figure F-1. A second memorandum incorporated newly discovered contaminated seeps into the wetland remediation system in 2005 (USAF, 2005).

Also in the 2005 memorandum, decision guides were adopted for shutting down wetland remediation system pumping stations (Appendix F, Figure F-3), and for re-starting an existing seep collection area or incorporating a new seep collection area for treatment (Appendix F, Figure F-4). A third memorandum to the site file described the transition of the wetland remediation system from an active to a passive treatment system as a non-significant change to the ROD (USAF, 2011c). Following the establishment of JBER in 2010, the 673d Air Base Wing Instruction, 32-7003, May 19, 2011 (USAF, 2011a) was revised to include LUCs from both installations to ensure consistency regarding the implementation of LUCs and to define management and compliance responsibilities.

RAOs were developed to identify actions needed to protect human health and the environment. The RAOs specified in the OU5 ROD include:

- Protect human health and the environment by preventing ingestion and contact with contaminated groundwater by people and preventing animal contact with contaminated seep water;
- Use treatment techniques whenever practicable;
- Implement a solution that is capable of managing impacts from upgradient sources as the contaminants reach OU5; and
- Implement a cost-effective solution that can achieve the cleanup levels for the final COCs.

These objectives define the site-specific COCs, exposure routes and receptors, and remediation goals, which are defined as acceptable contaminant levels for each exposure route. The primary types of contaminants are fuel-related chemicals and chlorinated solvents that are attributed to sources upgradient of OU5 where past spills or disposal occurred. The COCs and cleanup levels to be achieved as outlined in the ROD through implementation of the selected remedy are listed in Table 4-7.

Along with TCE and benzene, the ROD selected total fuel hydrocarbons (TFH)-diesel and TFH-gas as COCs for groundwater, and TFH-gas and grade 4 jet fuel as COCs in surface water. Because there was no specific cleanup standard for these compounds, the ROD set the cleanup standard at the ADEC water quality criterion for TAH. The ROD-specified cleanup levels for TFH-diesel and TFH-gas were conceptually modified in 1998 to include TAH and TAqH (USAF, 1998e). Because there was no standard for these COCs in groundwater, and because groundwater emerges at the seeps that eventually flow into Ship Creek (an aquaculture resource), the aquaculture water standards for TAH and TAqH are referenced, as documented in the 2005 OU5 memorandum to the site file (USAF, 2005).

Table 4-7
Cleanup Levels at Operable Unit 5

Chemical of Concern	ROD-Established Cleanup Level	Basis for Cleanup Level
Groundwater (µg/L)		
TCE	5	MCL[1]
Benzene	5	MCL[1]
Surface Water (µg/L)		
Sheen	No Sheen	18 AAC 70.020, based on ecological risk
TAH[2]	10	18 AAC 70.020, based on ecological risk
TAqH[2]	15	18 AAC 70.020, based on ecological risk
Soil (mg/kg)		
TFH-diesel[3]	1,000	18 AAC 78.315, ACM Level C

Notes:
[1] 40 CFR 131, 18 AAC 70.010a and d, 70.015 through 70.110, and 18 AAC.070.
[2] The ROD-specified cleanup levels for TFH-diesel and TFH-gas were conceptually modified in 1998 to include TAH and TAqH (USAF, 1998e). Because there was no standard for these COCs in groundwater, and because groundwater emerges at the seeps that eventually flow into Ship Creek (an aquaculture resource), the aquaculture water standards for TAH and TAqH are referenced (18 AAC 70.020, based on ecological risk).
[3] TFH-diesel is no longer sampled for at OU5 as the soil remedy has been completed (USAF, 2010e)
For definitions, see the Acronyms and Abbreviations section.

4.4.1 Operable Unit 5 Remedy Implementation and Status

The ROD-selected remedy was designed in 1996 (USAF, 1996e) and constructed and implemented in 1997 (USAF, 1998e). The major components of the selected remedy, as updated, and the current status of each through 2013 are provided in Table 4-8 and the text that follows.

Table 4-8
Operable Unit 5 Remedy Implementation Status

Remedy Component	Brief Status
Groundwater	
Institutional controls (also known as LUCs) that prohibit use of the upper aquifer will ensure that people will not be exposed to contaminated groundwater until cleanup goals are achieved. LUCs will be managed and implemented in accordance with Section 4.1 of the 2010 *LUC Memorandum to the Site File for Operable Units (OUs) 1, 2, 4, and 5* (USAF, 2010e). The LUC boundaries are depicted in Figures 4.3 and 4.4 of the 2010 *LUC Memorandum to the Site File for Operable Units (OUs) 1, 2, 4, and 5* (USAF, 2010e)	Implemented in July 1998. LUCs updated in memoranda to the site file in 2007 and 2010, and the May 2011 673d Wing Instruction 32-7003 *Land Use Control Management*. No LUC breaches were identified during the period under review.
Groundwater will be monitored to estimate the rate of natural attenuation, to provide an early warning of potential offsite contaminant migration, and to ensure protection of human health and the environment.	Ongoing. Monitoring frequency decision guide was adopted in 2003.
Seeps	
Seep water will be passively extracted from areas of contamination along the western and central bluffs. The water will be drained to the constructed wetland where enhanced natural chemical, physical and biological processes will reduce contamination below cleanup levels. Baffles will be installed to control flow of water and maintain retention time, and native vegetation will be put in place to help degrade contaminants.	Ongoing. Five newly discovered contaminated seeps were incorporated into the Wetland Remediation System in 2005. Decision guides for modifying the Wetland Remediation System due to changes in seep contaminant concentrations were adopted in 2005.

Table 4-8
Operable Unit 5 Remedy Implementation Status (Continued)

Remedy Component	Brief Status
The constructed wetland was built in the recommended location at the snowmelt pond, and a layer of gravel was placed over pond sediment.	Completed in 1997. Upon completion of an optimization study, the Wetland Remediation System was transitioned to a passive treatment system.
Seep water will be monitored near the exit of the Wetland Remediation System to ensure that the wetland is reducing concentrations below ADEC Water Quality Standards.	Ongoing.
Natural attenuation will be relied upon to treat seep and surface water in the Beaver Pond wetland area.	Ongoing.
Water from seeps and Beaver Pond wetland areas will be monitored to estimate the rate of natural attenuation and make sure that contamination does not reach Ship Creek.	Ongoing.
Soil	
Approximately 3,000 cubic yards of fuel-product contaminated soil will be excavated in the western and central areas and transported to an on-base treatment facility. Soil removed from the areas of contamination will be replaced by treated soil or clean fill from on base. Soil in the treatment facility will be monitored for contaminant concentration reduction. When the concentrations are below cleanup levels, the soil will be removed and used as fill around the base.	Excavation completed in 1997, and treatment completed in 1999.

Notes:
For additional definitions, see the Acronyms and Abbreviations section.

All remedial actions are operating and functional. As described in Section 4.7, LUCs have been established and are being maintained to prevent exposure until cleanup levels are attained. Groundwater, seep, surface water, and sediment monitoring is ongoing for OU5, though sediment sampling has been discontinued in all except one location due to consistent nondetect analytical results. Although sediment is identified in the ROD along with groundwater and surface water, no RAOs were established for sediment in the ROD and no cleanup levels were identified.

Monitoring plans are updated annually to ensure the program remains comprehensive and protective. Groundwater monitoring frequencies are established in accordance with the *Basewide Monitoring Program Well Sampling Frequency Decision Guide* (Appendix F, Figure F-1). The historical concentrations of TCE (the primary remaining COC) at key locations in OU5 are presented in ten figures in Appendix C:

- Figure C-8 illustrates the entire OU5 area and provides a frame of reference for the areas illustrated in subsequent figures.
- Figure C-9 illustrates groundwater monitoring data for the Fairchild Avenue Plume.
- Figure C-10 illustrates groundwater monitoring data for the OU5MW-02 Plume.
- Figure C-11 illustrates groundwater monitoring data for the Kenney Avenue Plume.
- Figure C-12 illustrates groundwater monitoring data for the Slammer Avenue Plumes.
- Figure C-13 illustrates groundwater monitoring data for the SP1-02 Plume.
- Figure C-14 illustrates seep and surface water data at the Wetland Treatment Cell area.
- Figure C-15 illustrates surface water site data from the Beaver Pond area.
- Figure C-16 illustrates monitoring data from Ship Creek.
- Figure C-17 illustrates early warning and sentry well data.

The groundwater, seep, and surface water sampling program for OU5 is designed to demonstrate protectiveness at the point of compliance, Ship Creek. Historical data concerning the number of wells/seeps/surface water points sampled annually at OU5 are provided in Appendix H. There are 22 plume wells that are monitored to track natural attenuation of source contamination. Between the plume wells and Ship Creek, 6 early warning wells and 11 sentry wells (Appendix C, Figure C-17) are monitored to determine whether the plumes are migrating toward Ship Creek. Seeps along the western and central bluff (many of which are captured by the wetland remediation system) and surface water/seeps in the Beaver Pond wetland area are monitored to track contaminant loading into the wetland remediation system and Beaver Pond wetland. The effluent from the wetland remediation system and the Beaver Pond wetland are monitored prior to their discharge into Ship Creek. Finally, Ship Creek is monitored at two locations. Groundwater monitoring results are evaluated annually, including trend analysis of COCs and assessment of natural attenuation parameters. The performance of the natural attenuation remedy is discussed below in the context of each of these components of the monitoring program1.

Over the past five years, several efforts have both contributed to, and extended this evaluation process, including the:

- Phases I, II, and III of the Wetlands Remediation system optimization (USAF, 2010b, 2010d);
- *ST37 TCE Plume and Source Area Investigation Report* (Draft-Final) (USAF, 2011g);
- *2011 Zones 1,2, and 3 Annual Report* (USAF, 2012b); and the
- *2012 Annual Monitoring Report for CERCLA Sites* (Final) (USAF, 2013).

The results of these efforts have helped delineate the size and shape of the TCE plumes. Plume and source area investigation activities were performed at ST037 in 2010. These activities were based on a recommendation made in the *Third Five-Year Review Report* (USAF, 2008a) to address slower rates of natural attenuation than were expected in the *OU5 ROD*. These activities are documented in the draft-final *ST37 TCE Plume and Source Area Investigation Report* (USAF, 2011g) which was approved by the EPA and ADEC via electronic mail notifications (Appendix I) received in November 2011. The draft-final version now serves as the final *ST37 TCE Plume and Source Area Investigation Report.*

One of the key findings from the 2010 plume and source area groundwater investigation was that the northern portion of the Fairchild Avenue Plume, the OU3MW-25 Plume, and the OU5MW-02 Plume may all be part of a larger, singular plume (the Fairchild Combined Plume). According to the investigation’s findings, the Fairchild Combined Plume may be a result of a former disposal site previously identified near the east-west runway, north of Fighter Drive and east of Fairchild Avenue (USAF, 2011g). Based on TCE concentrations, an additional source area may also be present in the vicinity of monitoring well 402WL-02.

The plume and source area groundwater investigation report also suggested that based on TCE concentrations, the southern portion of the Fairchild Avenue Plume is the result of a separate source area, most likely located in the vicinity of Building 6211 (USAF, 2011g).

Assessment of the performance of the natural attenuation remedy for groundwater contaminants in OU5 plume wells continues to evolve as more information becomes available during annual evaluations and other studies. The performance of natural attenuation is somewhat mixed. In some wells contaminants are degrading at a rate that will meet the cleanup levels by 2025. In other wells natural attenuation rates are much slower and some wells do not show decreasing concentration trends while others show no trend or increasing trends. In general, a realistic cleanup date for OU5 cannot be predicted at this time and most plumes are not expected achieve cleanup by 2025 (see Section 6.4.4).

More aggressive remedies to accelerate attainment of cleanup levels were considered, and a pilot-scale test of enhanced bioremediation at the Kenney Avenue Plume was initiated in 2006 (Henry, 2007). The enhanced bioremediation pilot test was not successful due to high groundwater flow rates, and because the organic substrate emulsion was not well retained in the large pore spaces of the aquifer. The technology might be successful if configured differently (such as a bioreactor model) in a contaminant source area. The ST037 TCE plume and source area investigation helped to further delineate the potential source areas contributing to the TCE contamination identified in the groundwater at OU5 (USAF, 2011g); however, the exact locations of the source areas still remains undetermined. If they can be identified, treatment of source areas offers the best opportunity to accelerate attainment of cleanup levels for OU5 plumes. Given that TCE concentrations in OU5 plumes are low (relative to solubility) and spread over a large area, identifying the source areas may prove difficult.

Early warning and sentry wells (Appendix C, Figure C-17) located between the identified plumes and Ship Creek are monitored to detect potential off site migration. The purpose of the early warning well system is to provide an indication of migration sufficiently early (2 years) so that funding can be obtained in time to implement contingency measures. The early warning and sentry wells include the following:

- Early warning wells: 516MW-02 (formerly well 76WL-01), SP4/11-03, OU5MW-01, OU5MW-05, OU5MW-11, OU5MW-45. Well 76WL-01 was replaced by well 516MW-02 due to well damage beyond repair.
- Sentry wells: 401WL-03, 401WL-04, NS3-02, SP2/6-05, OU5MW-09, OU5MW-10, OU5MW-12, OU5-MW13, OU5-MW14, OU5MW-31, OU5MW-33.

The monitoring activities for the early warning and sentry wells are intended to track chlorinated VOC concentrations in groundwater, detect any contamination above

OU5 ROD-specified cleanup levels (5 μg/L for TCE), and determine if contaminant concentrations increase to levels that might potentially affect environmental receptors, such as Ship Creek. Historically, COC concentrations have been measured using a fixed-based laboratory, but the USAF has used passive diffusion bag samplers in this area to reduce sampling costs. COC concentrations in all early warning and sentry wells have consistently remained below detection limits or cleanup levels since this monitoring program began in 1992 (USAF, 2013).

Sampling at seep and surface water locations has been conducted for more than a decade at a high frequency (up to four times per year). Data collected during this period have consistently demonstrated that the water quality of Ship Creek has not been affected by upgradient contamination, which suggests that a reduced seep and surface water sampling frequency would be sufficient to demonstrate compliance with ROD requirements and reduce costs.

The extent of the soil source area affecting groundwater and thereby contributing to the benzene and petroleum hydrocarbon contamination detected in seeps OU5SP-01 and OU5SP-02 is not well delineated. The extent of soil contamination that is resulting in elevated concentrations of benzene and petroleum products identified in seeps OU5SP-01 and OU5SP-02 should be identified as an assessment of residual soil contamination will be needed to predict the timeframe to meet RAOs at seeps OU5SP-01 and OU5SP-02. Monitoring data from the seeps flowing into the seep collection areas for Pump Station #2 and Pump Station #3 have demonstrated that operation of these pump stations and their associated seep collection areas are not needed to comply with the requirements of the OU5 ROD (USAF, 1995c). In addition, the overland flow cell has not been used as part of the wetland remediation system since fall 2008.

4.4.2 Operable Unit 5 System Operations and Maintenance

The wetland remediation system was constructed in 1996 to treat contaminated groundwater emerging from several seeps along the southern bluff of JBER-E. The purpose of the system was to remediate petroleum hydrocarbon contamination in seeps OU5SP-01 through

OU5SP-04 and TCE in five other seeps (OU5SP-09, OU5SP-10, OU5SP-11, OU5SP-17, and OU5SP-18) through a combination of passive and active system components.

The following components originally contributed to treatment:

- Gravel-lined collection areas for seeps OU5SP-01 through OU5SP-04 and OU5SP-09 through OU5SP-11
- Pump Stations #1, #2, and #3
- Overland Flow Cell for water collected from seeps OU5SP-01 through OU5SP-04
- Wetland Treatment Cell for effluent from the Overland Flow Cell and seeps OU5SP-09, OU5SP-10, OU5SP-11, OU5SP-17, and OU5SP-18

The primary treatment process in the seep collection areas is believed to be biodegradation, likely accomplished by a petroleum-degrading biofilm on the saturated gravel. Prior to 2007, water from the seep collection areas was transported via the three pump stations to the overland flow cell, which removed hydrocarbon contamination through a combination of volatilization and aerobic biodegradation that was enhanced by increasing dissolved oxygen concentrations in the water. Treated water from the overland flow cell was gravity fed into the wetland treatment cell, except during the coldest winter months; when the overland flow cell was shut down to prevent flooding. While the overland flow cell was shut down, water from the seep collection areas was pumped directly into the wetland treatment cell. The treatment processes active in the wetland treatment cell include volatilization, sorption, phytoremediation, and biodegradation. Retention time in the wetland is controlled and maintained at greater than five days to ensure that adequate remediation occurs. Effluent from the wetland treatment cell discharges to Ship Creek via underground culverts and ditches.

Over the past five years, components of the remediation system have been shut down based on analytical data which indicated that they were no longer needed or as part of an ongoing Wetland Remediation System Optimization Study (Optimization Study) described in the *2009 Zone 2 and Zone 3 Management Areas Work Plan* (USAF, 2009c) and performed during 2009 and 2010. The purpose of the Optimization Study was to evaluate whether the wetland remediation system could achieve treatment objectives established by the OU5 ROD without pump station operation.

Pump Station #3 was shut down in 2007 because concentrations of COCs in the associated seep (OU5SP-04) were below cleanup levels. As part of Phases I and II of the Optimization Study, conducted from March 25 through October 19, 2009, the overland flow cell was not re-started following the winter of 2008 through 2009, and Pump Stations #1 and #2 were shut down. The results of Phases I and II of the Optimization Study indicated that COC degradation within the two seep collection areas serviced by Pump Stations #1 and #2 was sufficient to achieve applicable cleanup standards within the seep collection areas prior to discharge from those areas. The results of Phases I and II of the Optimization Study are more fully described in a report published in March 2010 (USAF, 2010d).

Phase III of the Optimization Study was performed from October 19, 2009 through May 3, 2010, and included weekly inspections of the wetland treatment cell and monthly monitoring of discharge points for the Wetland Treatment Cell (WCSW-02) and the Pump Station #1 seep collection area (OU5CP-01). The results of Phase III, described in an addendum to the Optimization Study (USAF, 2010b) were generally consistent with the results of Phases I and II, with the exception that modifications to the configuration of the Pump Station #1 seep collection area were examined to 1) increase the retention time of COCs from seep OU5SP-02 in the collection area, and 2) maintain the water level within the collection area at an elevation below ground level. Design modifications included installation of baffles in the seep collection area to control water flow and increase retention time, and planting native vegetation to enhance natural contaminant degradation processes. Analytical data collected at wetland remediation system discharge points confirmed that COCs in wetland remediation system influent were effectively treated when the system was passively operated.

The USAF, EPA, and ADEC agreed to continue passive operation of the wetland remediation system in the *2011 OU5 Memorandum to the Site File* (USAF, 2011c) for a non-significant change to the OU5 ROD that formally changed the OU5 wetland remediation system treatment approach from an active (i.e., pumping) to a passive system.

Several practices are in place at the wetland remediation system to ensure continued operation of the system as designed:

- The O&M manual has been updated to provide standard procedures that ensure protectiveness of the system. The manual also provides procedures for troubleshooting and sampling.
- The influent and effluent of the wetland remediation system are sampled quarterly. The resulting analytical data are reviewed and evaluated annually.
- Flow is monitored in the wetland cell to ensure proper residence time.
- Maintenance of the wetland remediation system includes daily, weekly, quarterly, and annual site visits and procedures. Visual inspections of the system occur on a weekly basis. The inspections include visual checks of system components, water conditions, and any site conditions that may adversely affect operation of the system. Water in the, overland flow cell, and wetlands are checked for the presence of sheen or odor. Further, seep areas are checked for the presence of any new seeps, and contamination if new seeps are found.

Annual system O&M costs include planning and management, operation and maintenance of the wetland remediation system, sampling, monitoring, reporting, and five-year reviews. Annual LUC management costs include site inspections, photographic documentation, and reporting. In the ROD, annual costs for the OU5 remedy were estimated to be $80,000 per year.

As stated in the *Five-Year Review Report* (USAF, 2008a), the ROD-based estimate of O&M costs appears to have been underestimated. Actual monitoring costs alone are 25 to 100 percent greater than the ROD O&M estimate. During active operation of the wetland remediation system (e.g., active pumping), O&M of the wetland remediation system has been the largest portion of the O&M cost over the last 15 years. Optimization of treatment of seeps and surface water at OU5 has resulted in substantial cost savings by eliminating expenses associated with operation and maintenance of pumps. Since the wetland remediation system is now operating passively, O&M costs have been generally reduced. Historical O&M costs associated with OU5 are provided in Appendix H.

4.5 OPERABLE UNIT 6

OU6 consists of three source areas located north of the Elmendorf Moraine (LF004, WP014, and SD015) and three source areas located south of Ship Creek (LF002, LF003, and SD073) (Appendix A, Figure A-2). The OU6MW-46 Plume located upgradient of the WP014 plume has historically been included as part of Source Area WP014 (Appendix C, Figure C-20). Although it is no longer considered within the WP014 boundary, the OU6MW-46 Plume was included in the ROD and is monitored annually. LF002, LF003, and LF004 are former landfills. LF004, which overlooks Knik Arm of Cook Inlet, was used as a surface dump from 1945 to 1957. Exposed debris from LF004 North frequently erodes out of the bluff. WP014 and SD015 were petroleum, oil, and lubricant sludge disposal pits. SD073 consisted of surface drains in a building once used as a rock-testing laboratory with a surface disposal area next to the building. Table 2-1 provides a brief summary of the chronology of events at OU6.

A seventh source area, SS019, was included in the OU6 ROD even though it was not technically part of OU6. During 1995, an expedited response action to remove soil that was contaminated with the pesticide dieldrin was completed at SS019. As a result of the successful completion of the response action, the agencies have agreed this source area qualifies as NFA because the contaminated soils at SS019 have been satisfactorily removed and the residual risk is acceptable. The 1997 ROD for OU6 documents the removal action and NFA designation for SS019.

Pre-ROD response actions included the removal of a UST and petroleum-contaminated soils in the vicinity of a pump house building (State Program Site PL81 South) in 1996. Although this is a state-regulated site, the source is suspected to contribute to contamination at LF004 South. Additional investigation of source area WP014 led to removal of shallow soil in the vicinity of Valve Pit 11 (State Program Site PL81 North) in 2005. This portion of the state-regulated site was suspected to contribute to groundwater contamination at WP014.

The OU6 ROD was signed on January 27, 1997 (USAF, 1997e). Remedial actions were specified for each individual source area, including exposed debris removal and limited covers at LF002; annual removal of landfill debris along the beach (now Port of Anchorage expansion area) below LF004; periodic free-product recovery at LF004 and WP014; a high-vacuum extraction (HVE) system to treat contaminated groundwater and soil at SD015; excavation of contaminated soil at SD015; groundwater, surface water, and soil sampling at various source areas; and LUCs for LF002, LF003, LF004, WP014, and SD015. Due to minimal contamination, the OU6 ROD designated SD073 as NFA and selected LUCs as the only remedy for LF003.

The OU6 ROD has been updated three times:

- First, by a memorandum to the site file was issued to update monitoring frequency and establish a sampling frequency decision guide (USAF, 2003d) in September 2003. The sampling frequency decision guide is presented in Appendix F, Figure F-1.
- Second, the OU6 ROD was updated again with an ESD in March 2007 (USAF, 2007b). The ESD modified the SD015 remedy so that HVE system operations could be terminated when it became apparent that system was no longer effective, and MNA was selected as the remedy for the remaining contaminants. The ESD also adopted a new state cleanup standard for 1,1,2,2-tetrachloroethane (PCA) in groundwater at LF002 and SD015. The OU6 ROD identified 1,1,2,2-PCA as a COC for LF002 and SD015 groundwater, but no ARAR for 1,1,2,2-PCA existed at that time.
- Finally, the ESD also provided details on how LUCs would be implemented to comply with USAF policy. The ESD did not change the LUC performance objectives from the ROD. The ROD was updated again by a memorandum to the site file in 2008 (USAF, 2008e) to indicate that the beach below LF004 North had been filled as part of the Port of Anchorage expansion.

The USAF continues to remove debris annually from the base of the bluff (i.e., the location of the former beach). The expansion of the Port facilities has reduced wave-action erosion at LF004, and has also covered what was once the beach area with gravels.

The National Marine Fisheries Service designated critical habitat for Cook Inlet beluga whales in 2011 (*Endangered and Threatened Species*, 2011). In its critical habitat designation, National Marine Fisheries Service identified two distinct areas that are used by Cook Inlet beluga whales for different purposes at different times of year as well as two distinct exceptions noted as follows: (1) All property and overlying waters of JBER between Mean Higher High Water and Mean High Water; and (2) All waters off the Port of Anchorage which are east of a line connecting Cairn Point (61°15.4′ N., 149°52.8′ W.) and

Point MacKenzie (61°14.3′ N., 149°59.2′ W.) and north of a line connecting Point MacKenzie and the north bank of the mouth of Ship Creek (61°13.6′ N., 149°53.8′ W).

Prior to the Port of Anchorage expansion, wave action eroded and transported some LF004 debris below mean high water. Following the Port of Anchorage expansion, wave action and transportation of debris is no longer occurring. No portion of the LF004 site is within the critical habitat because the site is currently above the mean high water mark, but a portion of LF004 is adjacent to a portion of the critical habitat. Most of the western boundary of LF004 is adjacent to the exclusion zone around the Port of Anchorage (south of Cairn Point) but a portion of the LUC boundary extends north of this exclusion zone. A critical component of the consideration for exclusion of JBER lands from critical habitat designation was that JBER maintains an *Integrated Natural Resources Management Plan* which was found to provide benefit to Cook Inlet beluga whales. The *Integrated Natural Resources Management Plan* establishes coordination and consultation mechanisms with National Marine Fisheries Service on issues which may affect Cook Inlet beluga whales, and provides specific means to reduce potential harm due to military actions on the installation. As implemented, the current selected remedy for LF004 does not require any additional coordination or mitigation actions. If noise-making activities, heavy equipment use, or excavation activities become necessary to implement the remedy, coordination and consultations with the National Marine Fisheries Service will be necessary.

Another part of the critical habitat designation is the listing of five primary constituent elements essential to the conservation of the Cook Inlet beluga whales. The only element relevant to LF004 would be the element describing “waters free of toxins or other agents of a type and amount harmful to Cook Inlet beluga whales” (76 FR 20180). LF004 is unlikely to contribute any contaminants or water quality concerns and research has provided no evidence that water quality concerns involving LF004 contaminants have affected Cook Inlet beluga whales. The Port of Anchorage Expansion project and LF004 debris removal efforts should eliminate any possibility of LF004 contaminants or debris reaching Cook Inlet. An evaluation of the selected remedy as it applies to beluga whales was conducted during the 2008 five-year review. This evaluation determined the remedy selected for LF004 is protective of beluga whales.

Specific RAOs were developed as follows for each source area at OU6:

- Prevent the ingestion, dermal contact, and inhalation of vapors from the groundwater at LF004 South having benzene, toluene, ethylbenzene, 1,2-dichloroethane and methylene chloride in excess of MCLs and/or resulting in a cancer risk greater than 1.0×10^{-6} or hazard index greater than 1.
- Mitigate human dermal exposure, to the extent practicable, to landfill waste or debris at LF004 North.
- Mitigate exposure, to the extent practicable, of environmentally sensitive receptors to landfill waste at LF004 North. Relevant exposure pathways for wildlife include incidental ingestion of contaminated soil, ingestion of contaminated vegetation, and ingestion of contaminated animals (e.g., insects and earthworms).
- Prevent the ingestion, dermal contact, and inhalation of vapors from the groundwater at WP014 having benzene, ethylbenzene, and toluene in excess of MCLs and/or resulting in a cancer risk greater than 1.0×10^{-6} or hazard index greater than 1.
- Prevent the domestic use (i.e., use resulting from ingestion and dermal contact of water, and inhalation of vapors) of water in the perched aquifer at SD015, having benzene, ethylbenzene, toluene, 1,1,2,2-PCA, 1,1,2-trichloroethane, 1,2-dichloroethane, and TCE in excess of MCLs and/or resulting in a cancer risk greater than 1.0×10^{-6} or hazard index greater than 1.
- Prevent the possible migration of contaminants from soils at SD015 that have DRO, gasoline-range organics (GRO), and BTEX concentrations exceeding Alaska Cleanup Matrix Level D.
- Prevent the ingestion and dermal contact of water, and inhalation of vapors from water while bathing, for water from LF002 having 1,1,2,2-PCA in excess of cleanup goals and/or resulting in a cancer risk greater than 1.0×10^{-6}.
- Mitigate, to the extent practicable, human dermal exposure with lead-contaminated shallow soils and exposed landfill waste or debris present on the LF002 landfill surface.
- Preserve existing vegetation and ecological habitat at LF002 to the extent practicable.

The cleanup levels identified in the OU6 ROD and subsequent ROD updates, which are generally based on MCLs for groundwater and Alaska Cleanup Matrix Level D for soil contamination, are summarized in Table 4- 9.

Table 4-9
Cleanup Levels at Operable Unit 6

Location	Chemical of Concern	ROD-Established Cleanup Level	Basis for Cleanup Level
Groundwater (µg/L)			
LF002	1,1,2,2-Tetrachloroethane	4	18 AAC 75.345[1]
LF004 (South)	Benzene	5	MCL
	Ethylbenzene	700	MCL[2]
	Toluene	1,000	MCL[2]
	1,2-Dichloroethane	5	MCL[2]
	Methylene Chloride	5	MCL[2]
WP014	Benzene	5	MCL[2]
	Ethylbenzene	700	MCL[2]
	Toluene	1,000	MCL[2]
SD015	Benzene	5	MCL[2]
	Ethylbenzene	700	MCL[2]
	Toluene	1,000	MCL[2]
	1,1,2,2-Tetrachloroethane	4	18 AAC 75.345[1]
	1,1,2-Trichloroethane	5	MCL[2]
	Trichloroethene	5	MCL[2]
Soils (mg/kg)			
LF002	Lead	--[3]	
	Exposed Landfill Debris	--[3]	18 AAC 60.390
LF004 (North)	Exposed landfill debris	--	18 AAC 60.390
SD015	Gasoline-Range Organics	1,000	ACM, Level D[4]
	Diesel-Range Organics	2,000	ACM, Level D[4]
	BTEX	100	ACM, Level D[4]

Note:
[1] Basis for cleanup level is 18 AAC 75.345. ROD cleanup level updated in the OU6 ESD (USAF, 2007a).
[2] Basis for cleanup level is MCL; 40 CFR § 141.61 for federal MCLs and 18 AAC 80.070 for state standards established in the OU6 ROD (USAF, 1997a).
[3] ROD does not specify cleanup levels because risk analysis resulted in hazard index below standards. A lead uptake/biokinetic model was the basis of listing lead as a COC. For exposed landfill debris, Alaska Solid Waste regulations 18 AAC 60.390 for landfill closure apply (USAF, 1997a).
[4] Basis for cleanup level is Alaska Contaminant Matrix; 18 AAC 78.315 established in the OU6 ROD (USAF, 1997a).
For definitions, see the Acronyms and Abbreviations section.

4.5.1 Operable Unit 6 Remedy Implementation and Status

The major components of the selected remedy and the current status of each, through 2013, are provided in Table 4-10 and the text below. The design and construction of the remedies were conducted as a series of treatability studies which, once proved successful, were adopted as the final remedy (USAF, 1997c). These treatability studies included:

- Design (USAF, 1997f) and implementation (USAF, 1997d) of debris removal and limited soil cover at LF002, completed in October 1996;
- The initial landfill debris cleanup from the beach below LF004 conducted in June 1997 to determine the best practices for debris removal for future efforts (USAF, 1998h);
- Excavation and thermal treatment of shallow soils at SD015, conducted and completed in June and July 1996 (USAF, 1996b); and
- Design (USAF, 1996c), construction, startup, and implementation of a treatability study (USAF, 1998f) of the HVE system at SD015, which became fully operational as of December 11, 1996.

Table 4-10
Operable Unit 6 Remedy Implementation Status

Remedy Component	Brief Status
SOURCE AREA LF002	
Groundwater at LF002 (including Seeps)	
Access to groundwater at LF002 will be institutionally controlled. LF002 is currently designated as a "restricted use area" in the Base General Plan. This designation provides for recreational use of the parcel (e.g., cross-country skiing) and for construction of unmanned facilities such as a parking lot, storage building, or taxiway, but prohibits the construction of any sort of manned facility such as an office building or a residence. Drilling into the shallow aquifer is also restricted by the Base General Plan to prohibit residential or agricultural use of contaminated groundwater. (LUCs will be managed and implemented in accordance with the June 2007 ESD, Section 4.3).	Implemented September 1997. LUC procedures were updated and clarified in the 2007 ESD and May 2011 673d Air Base Wing Instruction 673d 32-7003 *Land Use Control Management*. No LUC breaches were identified during the period under review.

Table 4-10
Operable Unit 6 Remedy Implementation Status (Continued)

Remedy Component	Brief Status
Groundwater will be monitored as indicated by the *Basewide Monitoring Program Well Sampling Frequency Decision Guide* and evaluated on an as-needed basis to determine contaminant migration and to track the progress of contaminant degradation and dispersion, as well as to provide an early indication of unforeseen environmental or human health risk. Five-year reviews will also assess the protectiveness of the remedial action, including an evaluation of any changed site conditions, as long as contamination remains above cleanup levels.	Monitoring is ongoing to evaluate natural attenuation. A monitoring frequency decision guide was adopted in 2003. Five-year reviews were conducted in 1998, 2003 2008, and 2013.
Groundwater monitoring will be discontinued if contaminant levels are below cleanup levels during two consecutive monitoring events. In that case, NFA for groundwater will be required.	Groundwater monitoring is ongoing as required by the OU6 ROD.
During the final round of monitoring, samples will be collected and analyzed for all constituents that exceeded MCLs during the 1994 investigation including VOCs and semivolatile organic compounds. These results will be evaluated before a final determination is made that groundwater meets all cleanup requirements.	Contaminant concentrations are below cleanup levels at LF002 and final monitoring has been recommended.
All groundwater is expected to be cleaned up within 23 years.	Groundwater cleanup for LF002 appeared to be complete after six years (since 2003).
Soil at LF002	
Access to soil at LF002 will be institutionally controlled. LF002 is currently designated as a "restricted use area" in the Base General Plan. This designation provides for recreational use of the parcel (e.g., cross-country skiing) and for construction of unmanned facilities such as a parking lot, storage building, or taxiway, but prohibits the construction of any sort of manned facility such as an office building or a residence. (LUCs will be managed and implemented in accordance with the June 2007 ESD, Section 4.3).	Implemented September 1997. LUC procedures were updated and clarified in the 2007 ESD and in the May 2011 673d Air Base Wing Instruction 32-7003 *Land Use Control Management*. No LUC breaches were identified during the period under review.

Table 4-10
Operable Unit 6 Remedy Implementation Status (Continued)

Remedy Component	Brief Status
A limited soil cover will be applied in three areas with elevated lead concentrations at LF002. This will eliminate the pathway for contact with the lead contamination. Five-year reviews will be conducted to evaluate the integrity of the cover, evaluate impacts from any changed site conditions, and assess the continued protectiveness of this remedial action.	Soil covers and exposed debris removal completed in October 1996. Five-year reviews were conducted in 1998, 2003 2008, and 2013.
Landfill debris on top of or protruding from the ground surface at LF002 will also be removed as part of the specific remedy for this area.	Soil covers and exposed debris removal completed in October 1996.
Hazardous materials encountered during the removal event will be handled according to appropriate regulations. NFA will be required as a means of closing the LF002 landfill.	Any hazardous materials have been disposed of in accordance with appropriate regulations.
SOURCE AREA LF003	
Groundwater at LF003	
Access to groundwater at LF003 will be institutionally controlled. LF003 is currently designated as a "restricted use area" in the Base General Plan. This designation provides for recreational use of the parcel (e.g., cross-country skiing) and for construction of unmanned facilities such as a parking lot, storage building, or taxiway, but prohibits the construction of any sort of manned facility such as an office building or a residence. Drilling into the shallow aquifer is also restricted by the Base General Plan to prohibit residential or agricultural use of contaminated groundwater. (LUCs will be managed and implemented in accordance with the June 2007 ESD, Section 4.3).	Implemented August 1998. LUC procedures were updated and clarified in the 2007 ESD and the May 2011 673d Air Base Wing Instruction 32-7003 *Land Use Control Management*. No LUC breaches were identified during the period under review.
Soil at LF003	
Access to soil at LF003 will be institutionally controlled. LF003 is currently designated as a "restricted use area" in the Base General Plan. This designation provides for recreational use of the parcel (e.g., cross-country skiing) and for construction of unmanned facilities such as a parking lot, storage building, or taxiway, but prohibits the construction of any sort of manned facility such as an office building or a residence. (LUCs will be	Implemented August 1998. LUC procedures were updated and clarified in the 2007 ESD and the May 2011 673d Air Base Wing Instruction 32-7003 *Land Use Control Management*. No LUC breaches were identified during the period under review.

Table 4-10
Operable Unit 6 Remedy Implementation Status (Continued)

Remedy Component	Brief Status
managed and implemented in accordance with the June 2007 ESD, Section 4.3).	
SOURCE AREA LF004	
Groundwater at LF004 North/Beach	
NFA is required for the groundwater at LF004 North/Beach.	NFA.
Groundwater at LF004 South	
Access to groundwater at LF004 South will be prevented through the implementation of LUCs. LF004 is currently designated as a "restricted use area" in the Base General Plan. This designation provides for recreational use of the parcel (e.g., cross-country skiing) and for construction of unmanned facilities such as a parking lot, storage building, or taxiway, but prohibits the construction of any sort of manned facility such as an office building or a residence. Drilling into the shallow aquifer is also restricted by the Base General Plan to prohibit residential or agricultural use of contaminated groundwater. (LUCs will be managed and implemented in accordance with the June 2007 ESD, Section 4.3).	Implemented August 1998. LUC procedures were updated and clarified in the 2007 ESD and the May 2011 673d Air Base Wing Instruction 32-7003 *Land Use Control Management*. No LUC breaches were identified during the period under review.
Groundwater will be monitored and evaluated as indicated by the *Basewide Monitoring Program Well Sampling Frequency Decision Guide* to determine contaminant migration and to track the progress of contaminant degradation and dispersion, as well as to provide an early indication of unforeseen environmental or human health risk. Five-year reviews will also assess the protectiveness of the remedial action, including an evaluation of any changed site conditions, as long as contamination remains above cleanup levels.	Monitoring is ongoing to evaluate natural attenuation. A monitoring frequency decision guide was adopted in 2003. Five-year reviews were conducted in 1998, 2003 2008, and 2013.
Recoverable quantities of free product found on top of the water table at LF004 South will be regularly removed during groundwater monitoring events.	Ongoing. No recoverable quantities of free product have been detected since 2005.

Table 4-10
Operable Unit 6 Remedy Implementation Status (Continued)

Remedy Component	Brief Status
Groundwater monitoring will be discontinued if contaminant levels are below cleanup levels during two consecutive monitoring events, in which case, NFA for groundwater will be required.	Groundwater monitoring is ongoing as required by the OU6 ROD.
During the final round of monitoring, samples will be collected and analyzed for all constituents that exceeded MCLs during the 1994 investigation including VOCs, semivolatile organic compounds, and metals. These results will be evaluated before a final determination is made that groundwater meets all cleanup requirements. (Table 3.1 of the 2007 ESD provides a list of specific constituents to be sampled and analyzed).	Groundwater samples continue to exhibited contaminant concentrations exceeding MCLs at LF004.
All groundwater is expected to be cleaned up within 14 years.	Groundwater cleanup is ongoing and current trends predict that remediation will require more than 30 years from the signing of the 1997 ROD to achieve cleanup goals.
Soil at LF004 North	
Access to soil at LF004 North will be institutionally controlled. LF004 is currently designated as a "restricted use area" in the Base General Plan. This designation provides for recreational use of the parcel (e.g., cross-country skiing) and for construction of unmanned facilities such as a parking lot, storage building, or taxiway, but prohibits the construction of any sort of manned facility such as an office building or a residence. (LUCs will be managed and implemented in accordance with the June 2007 ESD, Section 4.3).	Implemented August 1998. LUC procedures were updated and clarified in the 2007 ESD and the May 2011 673d Air Base Wing Instruction 32-7003 *Land Use Control Management*. Reference to "beach" in the ROD was removed by the 2008 memorandum to the site file when the Port of Anchorage filled in the former beach below LF004 North with soil and gravel as part of its facility expansion in 2007. No LUC breaches were identified during the period under review.

Table 4-10
Operable Unit 6 Remedy Implementation Status (Continued)

Remedy Component	Brief Status
NFA is required for soil contamination at LF004 North; however, landfill debris on the Port of Anchorage fill that is adjacent to LF004 will be removed annually as the specific remedy for this area.	Debris removal has been conducted annually since 1997. The Port of Anchorage filled in the former beach below LF004 North with soil and gravel as part of its facility expansion in 2007, and this changed condition was documented in a 2008 memorandum to the site file. Five-year reviews were conducted in 1998, 2003, 2008, and 2013.
The removal of debris will include all LF004 landfill material that has fallen onto the newly constructed Port of Anchorage fill and can be reasonably collected for disposal, as well as debris on the bluff slope or other low lying areas which can be accessed and removed without hazard.	Debris removal has been conducted annually in the specified areas.
Hazardous materials encountered during the annual removal events will be handled according to appropriate regulations.	Any hazardous materials (e.g. asbestos -containing material and unexploded ordnance) have been disposed of in accordance with appropriate regulations.
The removal of fallen debris from LF004 is expected to continue annually for 30 years or as long as the landfill remains subject to erosional action. Five-year reviews will assess the protectiveness of the remedial action, including an evaluation of any changed site conditions.	The Port of Anchorage expansion has reduced the magnitude of erosion caused by tidal action but unvegetated and undercut areas are still subject to erosion and sloughing. Five-year reviews were conducted in 1998, 2003, 2008, and 2013.
NFA will be required as a means of closing the LF004 landfill.	NFA.
Soil at LF004 South	
NFA is required for the soil at LF004 South.	NFA.

Table 4-10
Operable Unit 6 Remedy Implementation Status (Continued)

Remedy Component	Brief Status
SOURCE AREA WP014	
Groundwater at WP014	
Institutional controls (also known as LUCs) on land and water use, as specified in the Base General Plan, will restrict access to the contaminated groundwater throughout WP014. Installation of wells in the contaminated plume for residential, industrial, and agricultural use will be prohibited by the Base General Plan. (LUCs will be managed and implemented in accordance the June 2007 ESD, Section 4.3).	Implemented in August 1998. LUC procedures were updated and clarified in the 2007 ESD and the May 2011 673d Air Base Wing Instruction 32-7003 *Land Use Control Management*. No LUC breaches were identified during the period under review.
Groundwater will be monitored as indicated by the *Basewide Monitoring Program Well Sampling Frequency Decision Guide* and evaluated on an as-needed basis to determine contaminant migration and to track the progress of contaminant degradation and dispersion, as well as to provide an early indication of unforeseen environmental or human health risk. Five-year reviews will also assess the protectiveness of the remedial action, including an evaluation of any changed site conditions, as long as contamination remains above cleanup levels.	Monitoring is ongoing to evaluate natural attenuation. A monitoring frequency decision guide was adopted in 2003. Five-year reviews were conducted in 1998, 2003, 2008, and 2013.
Recoverable quantities of free product found on top of the water table at WP014 will be regularly removed during groundwater monitoring events.	Ongoing. No recoverable quantities of free product have been detected since 2005.
Groundwater monitoring will be discontinued if contaminant levels are below cleanup levels during two consecutive monitoring events. In that case, NFA for groundwater will be required.	Groundwater monitoring is ongoing at WP014 as required by the OU6 ROD.
During the final round of monitoring, samples will be collected and analyzed for all constituents that exceeded MCLs during the 1994 investigation including VOCs, semivolatile organic compounds, and metals. These results will be evaluated before a final determination is made that groundwater meets all cleanup requirements.	Groundwater samples continue to exhibit contaminant concentrations exceeding MCLs at WP014.
All groundwater is expected to be cleaned up within 14 years.	Groundwater cleanup is ongoing, but a realistic cleanup date cannot be predicted with existing data.

Table 4-10
Operable Unit 6 Remedy Implementation Status (Continued)

Remedy Component	Brief Status
Soil at WP014	
NFA will be required for the soil at WP014.	NFA. Additional investigation of source area WP014 led to removal of shallow soil in the vicinity of Valve Pit 11 (state program site PL81) in 2005. This portion of the state-regulated site was suspected to contribute to groundwater contamination at WP014.
SOURCE AREA SD015	
Perched Aquifer Groundwater at SD015	
Institutional controls (also known as LUCs) on land and water use, as specified in the Base General Plan, will restrict access to the contaminated groundwater throughout SD015. Installation of wells in the contaminated plume for residential, industrial, or agricultural use will be prohibited by the Base General Plan. (LUCs will be managed and implemented in accordance with the June 2007 ESD, Section 4.3).	Implemented in August 1998. LUC procedures were updated and clarified in the 2007 ESD and the May 2011 673d Air Base Wing Instruction 32-7003 *Land Use Control Management*. No LUC breaches were identified during the period under review.
Groundwater in the perched aquifer at SD015 will be treated by HVE and MNA to remove fuel-related contaminants and halogenated VOCs.	The HVE system was installed and began operating in 1996, and operated for more than 10 years. The HVE system was permanently shut down in May 2007 when it was no longer effectively removing contaminants. The system was decommissioned in 2008. The remedy was modified by 2007 ESD, which selected MNA as the remedy for the remaining groundwater contamination at SD015. MNA at SD015 is ongoing.
Recoverable quantities of free product found on top of the water table at SD015 will be removed through the HVE process.	The HVE system was permanently shut down in May 2007 when it was no longer effectively removing contaminants.
Treated water will be re-injected into the subsurface beyond the boundary of the contaminated aquifer. Re-injected water will be regularly monitored to ensure that it meets cleanup and risk requirements.	The HVE system was permanently shut down in May 2007 when it was no longer effectively removing contaminants.

Table 4-10
Operable Unit 6 Remedy Implementation Status (Continued)

Remedy Component	Brief Status
Groundwater will continue to be monitored as indicated by the *Basewide Monitoring Program Well Sampling Frequency Decision Guide* and evaluated on an as-needed basis to determine contaminant migration, to track the progress of contaminant degradation and dispersion and progress of the SD015 HVE treatment, as well as to provide an early indication of unforeseen environmental or human health risk. Five-year reviews will also assess the protectiveness of the remedial action, including an evaluation of any changed site conditions, as long as contamination remains above cleanup levels.	Monitoring is ongoing to evaluate MNA. A monitoring frequencies decision guide was adopted in 2003. HVE treatment at SD015 was completed and shut down in 2007, and MNA was selected as the remedy for the remaining groundwater contamination. Five-year reviews were conducted in 1998, 2003, 2008, and 2013.
HVE will be terminated when operations become ineffective. MNA will be used to reduce groundwater contaminant concentrations to below cleanup levels.	The HVE system was permanently shut down in May 2007 when it was no longer effectively removing contaminants. MNA at SD015 is ongoing.
During the final round of groundwater monitoring, samples will be collected and analyzed for all constituents that exceeded MCLs during the 1994 investigation, including VOCs and arsenic. These results will be evaluated before a final decision is made that groundwater meets all cleanup requirements.	Groundwater monitoring is ongoing at all sites as required by the OU6 ROD.
Groundwater cleanup standards are expected to be met at all wells by 2015.	Groundwater cleanup is ongoing and current trends predict it will be completed in 27 years (2023).
Deep Aquifer Groundwater at SD015	
NFA is required for the deep aquifer groundwater at SD015.	NFA.
Soil at SD015	
Shallow soils (less than 5 feet deep) with contamination above cleanup levels will be excavated, removed, and thermally treated to eliminate fuel-related contaminants. After treatment, NFA will be required for the shallow soils. Shallow soil will also be included in the HVE extraction	Excavation/thermal treatment completed in 1997. Additional contaminated shallow soils were treated with HVE and soil vapor extraction. All shallow soils met cleanup levels as of 2005. Additional

Table 4-10
Operable Unit 6 Remedy Implementation Status (Continued)

Remedy Component	Brief Status
treatability study.	shallow contaminated soil was encountered in 2008 and removed in 2009.
Deep soils at SD015 will be actively treated through air stripping associated with the HVE process described for the perched aquifer groundwater.	All SD015 soils met cleanup levels as of 2005. During additional investigation in 2011 contaminants were found to meet ROD-specified cleanup levels but exceeded current state cleanup levels. TCE was not listed as a COC in the ROD but exceeds current state standards. There are no occupied buildings at SD015 within 100 feet of a contaminated groundwater plume. Benzene and TCE are currently monitored in the groundwater
Soils with contamination above cleanup levels will be sampled one year after HVE system start up and every three years thereafter to evaluate contaminant migration and timely reduction of contaminant concentrations by HVE. If cleanup levels are not being achieved, further remedial action will be evaluated. This will include five-year reviews to assess the protectiveness of the remedial action, including an evaluation of any changed site conditions, as long as contamination remains above cleanup levels.	All SD015 soils met cleanup levels as of 2005. Five-year reviews were conducted in 1998, 2003, 2008, and 2013. Additional shallow contaminated soil was encountered in 2008 and removed in 2009.
HVE will be terminated when operations become ineffective. MNA will be used to reduce groundwater contaminant concentrations below cleanup levels.	The HVE system was permanently shut down in May 2007 when it was no longer effectively removing contaminants, in accordance with the 2007 ESD. The 2007 ESD selected MNA as the remedy for the remaining groundwater contamination at SD015, which is ongoing.
All soils are expected to be cleaned up within five years.	All soils were cleaned up in 9 years (since 2005).

Note:
For definitions, see the Acronyms and Abbreviations section.

Implementation of all components of the remedy was documented in the *OU6 Remedial Action Report* (USAF, 1998c). As of February 20, 1998, EPA and ADEC concurred that all OU6 remedy components were in place and functional. The OU6 remedy components continue to be operational and functional over the past five years, and the performance of each remedial action component is described below.

Groundwater is monitored at LF002, LF004 South, WP014, and SD015 to assess contaminant migration and the timely reduction of contaminant concentrations by natural attenuation, and, prior to its shutdown, to monitor progress of the HVE system at SD015. The groundwater monitoring program is evaluated and updated annually in accordance with the monitoring frequency decision guide (Appendix F, Figure F-1) to ensure that the program remains comprehensive and protective. Historical data concerning the number of wells/seeps water points sampled annually at OU6 are provided in Appendix H.

Several key changes were made to the monitoring plan during the past five years. In 2010, changes were made to the LF004 South and WP014 monitoring program to incorporate recommendations from the previous five-year review and align the monitoring activities to the OU6 ROD. Monitoring well OU6MW-61 and chlorinated solvents were added back into the program for LF004 South. Monitoring well OU6MW-77 was evaluated for inclusion in the monitoring program at WP014 but continues to have free product in the well. At the time of the ROD, chlorinated solvents were limited to just a few wells: OU6MW-61, OU6MW-67, and OU6MW-77.

Sampling activities were discontinued for monitoring well OU6MW-61 in 1994, upon completion of the RI. Chlorinated solvents did not exceed cleanup levels in OU6MW-67 and OU6MW-77 after 1996 and these compounds were removed from the monitoring program per the decision guide. No justification was provided for the discontinuation of sampling activities for monitoring well OU6MW-61; therefore, the 2008 five-year review recommended sampling OU6MW-61 for chlorinated COCs and re-aligning the monitoring program to reflect LF004 South COCs in appropriate wells. This was implemented in 2010 when the monitoring program included chlorinated solvents in the list of COCs for OU6MW-61, OU6MW-63, and OU6MW-67 as well as seeps LF04SP-02, LF04SP-02DG, LF04SP-03, and LF04SP-04.

Figures C-18 through C-21 (Appendix C) present the results of COCs at key wells in OU6. Groundwater monitoring results are evaluated annually, including trend analysis of COCs and assessment of natural attenuation parameters. The progress of natural attenuation at OU6 has been mixed. Groundwater at LF002 currently meets cleanup levels, and groundwater at LF004 South may also meet cleanup levels for chlorinated solvent COCs (see Section 6.4.5). However, concentrations of some COCs show either no trend or an increasing trend, and no cleanup date can be predicted. Results of these analyses are discussed in detail in Section 6.4.5.

Wells at WP014 and LF004 South were checked annually for free product. If more than 0.1 feet of product is detected in a well, the free product is removed. Free product in excess of 0.1 feet was detected at WP014 in 2010. Overall, recoverable free product does not remain at existing well locations at these sites.

The beach or Port of Anchorage expansion area (since 2007) below LF004 is inspected periodically and debris has been removed annually. Debris collected has been disposed of in accordance with the National Oil and Hazardous Substances Pollution Contingency Plan – Offsite Disposal Rule promulgated under 40 CFR § 300.440. The debris removal activities are summarized in Table 4-11.

Table 4-11
Debris Removal from LF004 North

Year	Quantity Removed (Tons)	Material Classification	Other Material Removed
1997	98	General debris, mostly metal	One roll of asbestos wrap, one large battery, two small transformers, twenty-five 5-gallon drums and five 5- to 10-gallon drums with unknown contents.
1998	15	General Debris	No unexploded ordnance or asbestos-containing material identified.
	10	Recyclable Material	
1999	29	General Debris	No asbestos-containing material identified. Explosive ordnance disposal personnel removed small arms ammunition, shells, casings, and one Howitzer shell casing.
2000	12	Nonhazardous solid waste	No unexploded ordnance or asbestos-containing material identified.
2001	34	Nonhazardous solid waste	No unexploded ordnance or asbestos-containing material identified. A cylinder with unknown contents was secured in place and left for the next field season.
2002	18	Nonhazardous solid waste, mostly metal, some concrete, rubber, and vehicle parts	Forty rifle casings, one steel cylinder.
2003	16.9	Nonhazardous solid waste, mostly metal, some rubber, electrical components, and wood	One .30- and one .50-caliber shell casing, 820 pounds of asbestos-containing material (pipe).
2004	3.6	Nonhazardous solid waste, mostly metal, some rubber, electrical components, and wood	One previously perforated cylinder apparently containing seawater.
2005	11.1	Nonhazardous solid waste, mostly metal, some rubber, electrical components, and wood	One .50-caliber shell casing, two compromised batteries, 40 pounds of asphaltic material, and 200 pounds of asbestos-containing material (cementitious board and pipe).

Table 4-11
Debris Removal from LF004 North (Continued)

Year	Quantity Removed (Tons)	Material Classification	Other Material Removed
2006	7.2	Nonhazardous solid waste, mostly metal, some rubber, electrical components, and wood	100 pounds of asbestos-containing material (pipe), one lighting ballast (PCB).
2007	8.5	Nonhazardous solid waste, mostly metal, electrical components, and wood	Pack of solder rod, a water heater, one lead battery, 120 pounds of asbestos-containing material (cementitious board and pipe).
2008	0.14	Nonhazardous solid waste, mostly metal and glass	Small pieces of ceramic cookware.
2009	0.15	Nonhazardous solid waste, mostly metal and glass	No unexploded ordnance or asbestos-containing material identified.
2010	0.25	Nonhazardous solid waste, mostly metal, glass, and burned debris	No unexploded ordnance or asbestos-containing material identified.
2011	0.42	Nonhazardous solid waste, mostly metal, glass, and burned debris	No unexploded ordnance or asbestos identified.
2012	0.025	Nonhazardous solid waste, mostly metal scrap, household items, and a tire	No unexploded ordnance or asbestos-containing material identified.

Note:
For definitions, see the Acronyms and Abbreviations section.

The mass of debris from LF004 North that is annually found and removed has decreased over the past 17 years. In 2007, the Port of Anchorage expanded its facilities, including filling over most of the former beach area below LF004 North (USAF, 2008c, 2008e). The Port of Anchorage expansion will not change implementation of the LF004 remedies, but appears to have decreased the potential for tidal erosion at LF004 North.

Surface soil samples were last collected from LF004 North in 2007 to determine whether contaminant concentrations have changed since the ROD (USAF, 2008c). Sediment samples are no longer collected because the former beach area has been filled by the Port of Anchorage expansion, as documented in a 2008 memorandum to the site file (USAF, 2008e).

Seep sampling at LF004 North was discontinued after 2006 because no significant contamination has ever been detected.

Per requirements of the OU6 ROD, which includes Site SD015, a soil vapor extraction system (SVE) system and HVE system were designed, installed, and operated for treatment of perched groundwater at this site. The HVE system at SD015 operated from December 1996 until it was shut down in May 2007 (Weston Solutions Inc., 2007). Over its 10.5-year lifecycle, the HVE system operated for 53,690 hours or an overall 58 percent operational rate. Several upgrades were attempted to improve efficiency, including upgrades to reduce downtime in late 2002 and installation of four shallow SVE wells in December 2003. These efforts temporarily improved efficiency; the SVE system removed over 90 percent of the total VOCs removed since 2003. However, by 2007, the HVE system reached the end of its lifecycle by removing virtually all recoverable contaminants. Soil sampling conducted in August 2005 confirmed that shallow and deep soil meet cleanup levels for all soil COCs at SD015 (USAF, 2006a).

An ESD, which was signed by USAF in June 2007 and accepted by EPA and ADEC in August 2007, transitioned the remedy for the SD015 perched groundwater plume to MNA (USAF, 2007a). The HVE system was shut down and the HVE and SVE systems were decommissioned in 2008. During excavation of treatment system piping in 2008, fuel-contaminated soil was encountered along the south side of former concrete pad No. 2. In 2009, approximately 250 cubic yards of contaminated soil was removed from this area (USAF, 2009b). Additional investigation of the nature and extent of remaining contamination in this area was completed in 2011. DRO, GRO, and benzene were found to meet ROD-specified cleanup levels but exceeded current State of Alaska cleanup levels. TCE was not listed as a COC in the ROD but exceeds current state standards. Benzene and TCE are currently monitored in the groundwater.

Currently, two monitoring wells are located on the SD015 site: OU6MW-17 and OU6MW-90. Monitoring well OU6MW-18 was abandoned on August 26, 2011 after it was found to be unusable. As documented in a Technical Memorandum (USAF, 2012e), following the abandonment of monitoring well OU6MW-18, the installation of replacement well

OU6MW-18R was attempted. A soil boring was initially advanced to approximately 60 feet bgs (the screened depth of monitoring well OU6MW-18); however, no water was identified. The soil boring was continued to approximately 70 feet bgs; however, water was still not identified and the replacement well was, therefore, not completed (USAF, 2012e). Monitoring well OU6MW-18 was last sampled in 2010, and concentrations of benzene and TCE exceeded cleanup levels. Monitoring well OU6MW-90 was last sampled in 2009, and concentrations of benzene exceeded cleanup levels. At SD015, only benzene and TCE remain above groundwater cleanup levels in monitoring well OU6MW-17.

At OU6, LUCs have been established and are being maintained to prevent exposure until cleanup levels are attained (see Section 4.7). Following the establishment of JBER in 2010, the 673d Air Base Wing Instruction 32-7003 (May 19, 2011 [USAF, 2011a]) was revised to include LUCs from both installations to ensure consistency regarding the implementation of LUCs and to define management and compliance responsibilities. Generally LUC processes include establishing and recording LUC boundaries in the Base General Plan, preventing incompatible construction on sites through the Work Clearance Request process, and conducting monitoring/inspections to look for any unauthorized or inappropriate activity (USAF, 2011a). Results of LUC inspections are recorded in annual monitoring reports (USAF, 2012b). In addition to these general LUCs, additional controls limit access to soil and debris at LF004 include the following:

- Fencing at the south end of LF004 limits access to the site via the recreational trail that extends along the top of the Knik Arm Bluff. Additionally, access roads that extend from JBER-E to the Port of Anchorage are gated and locked. Signage located at the LF004 gate states that hazards exist at the site and unauthorized access is not allowed. Additional control limits require that authorized visitors sign in/out when accessing the area through the gate at the Knik Bluff Trail.
- Access control practices include annual inspection and maintenance of fencing and signs, patrols of the LF004 bluff area by JBER-E Security Police, and coordination with Port of Anchorage security to monitor and minimize access through the Port of Anchorage.

4.5.2 Operable Unit 6 System Operations and Maintenance

Annual O&M costs include planning and management, groundwater monitoring, debris removal, reporting, and five-year reviews. Annual LUC management costs include site inspections, photographic documentation, and reporting. All soil cleanup goals have been met (USAF, 2006a). The remaining groundwater COCs are being addressed through MNA. Debris removal at LF004 is conducted in accordance with operations and management plans that are periodically updated.

The estimated annual O&M costs for OU6 as presented in the ROD totaled a maximum of $178,400/year and included:

- WP014/LF004 South groundwater monitoring and free-product removal: $46,500/year for 14 years;
- LF004 debris removal: $9,700/year for 30 years;
- SD015 HVE system: $93,900/year for 4.5 years; and
- LF002 groundwater monitoring: $28,300/year for 23 years.

O&M costs for OU6 are somewhat inconsistent, but on average were considerably higher than estimated at the time of the ROD. With the exception of 2012, O&M costs for OU6 have decreased substantially in the past five years. The HVE and SVE system at SD015 was decommissioned in 2008, thereby eliminating future O&M costs for this system. Annual debris removal at LF004 continues but costs have decreased because the amount of debris recovered has decreased over time and the Port of Anchorage expansion project may further reduce erosion at LF004. As such, no issues with the remaining OU6 O&M costs indicate future problems with remedy. Historical O&M costs associated with OU6 are provided in Appendix H.

4.6 DP098

DP098 is located in the northwest portion of the base, northwest of Buildings 18220 and 18224 (formerly Buildings 41-755 and 41-760) (Appendix A, Figure A-2). DP098 is situated on the local topographic rise that slopes downward to the north into a wetland area approximately 400 feet from Building 18224 (USAF, 2004a). The underlying unconfined aquifer has a total saturated thickness ranging from 5 to 65 feet and generally flows to the north. The seeps are intermittent and occur during or following high rainfall events. The wetland receives runoff water in the spring and is dry the rest of the year. The DP098 ROD was signed on June 17, 2004 (USAF, 2004a). The selected remedial actions included a limited source removal, offsite treatment, and disposal of contaminated soils; a treatability study; MNA for groundwater; and LUCs. A brief chronology of events leading up to the ROD signing has been provided in Table 2-1.

Following the establishment of JBER in 2010, the 673d Air Base Wing Instruction, 32-7003, May 19, 2011 (USAF, 2011a) was revised to include LUCs from both installations to ensure consistency regarding the implementation of LUCs and to define management and compliance responsibilities.

The cleanup levels identified in the DP098 ROD are summarized in Table 4-12. Specific RAOs developed for DP098 are listed below:

- Reduce chlorinated solvent concentrations in soil, sediment, and groundwater to chemical-specific ARARs;
- Select remedial action alternatives that will minimize the damage to the wetland ecology;
- Prevent exposure (via ingestion, inhalation, and/or dermal contact) to groundwater until such time as the federal and state drinking water standards are met;
- Restrict excavations and the installation of water wells to reduce the possibility of exposure to contaminants and contaminant migration from the contaminated aquifer to the uncontaminated aquifers; and
- Maintain current land-use designations at this site.

Table 4-12
Cleanup Levels at DP098

Chemical of Concern	ROD-Established Cleanup Level	Basis for Cleanup Level
Groundwater (µg/L)		
1,1-Dichloroethene	7	MCL[1]
cis-1,2-Dichloroethene	70	MCL[1]
Trichloroethene	5	MCL[1]
Tetrachloroethene	5	MCL[1]
Vinyl Chloride	2	MCL[1]
Soil (mg/kg)		
1,1-Dichloroethene	0.03	18 AAC 75.341[2]
cis-1,2-Dichloroethene	0.2	18 AAC 75.341[2]
Trichloroethene	0.03	18 AAC 75.341[2]
Tetrachloroethene	0.027	18 AAC 75.341[2]
Sediment (mg/kg)		
cis-1,2-Dichloroethene	0.2	18 AAC 75.341[2]
Trichloroethene	0.027	18 AAC 75.341[2]

Notes:
[1] Basis for cleanup level is MCL; 40 CFR 141.61 for federal MCLs and 18 AAC 75 for state standards established in the DP098 ROD (USAF, 2004d).
[2] Basis for cleanup level is 18 AAC 75.341 Table B1, Method Two (ADEC, 2012).

4.6.1 DP098 Remedy Implementation and Status

The major components of the selected remedy and the current status of each, through 2013, are provided in Table 4-13 and the text that follows.

Table 4-13
DP098 Remedy Implementation Status

Remedy Component	Brief Status
Soil	
Excavation will be limited to soil within a 25-foot radius of soil boring DP98-SB01, where the greatest TCE concentrations were detected, adjacent to the end of the drain tile north of Building 18224.	Completed in 2005.
LUCs are an integral part of the selected remedy at DP098. The LUCs are designed to prevent activities that could affect the performance of the other components of the selected remedy, prevent the migration of contaminants in groundwater, and maintain current land uses at DP098 to protect human health and the environment. The specific LUCs associated with soil at DP098 are as follows: • Excavating, digging, or drilling in the ROD-specified area is restricted to reduce the possibility of migration or exposure to contaminants that exceed the chemical-specific ARARs. If contaminated soil that exceeds chemical-specific ARARs is excavated, it cannot be transported to or disposed of at another location on base. Excavated soil will be transported to a disposal facility in the lower 48 states, which is acceptable for disposal of CERCLA waste under the Offsite Disposal Rule (40 CFR §300.440). The current land use will be maintained to reduce the possibility of exposure to contaminants.	Implemented in May 2002. Updated the 673d Air Base Wing Instruction 32-7003 *Land Use Control Management* in May 2011. No LUC breaches were identified during the period under review.
Groundwater	
The MNA component of the selected remedy has three sub-components to assess the effectiveness of MNA: 1) natural attenuation of contaminants in groundwater, soil, and sediment; 2) a treatability study to determine the effectiveness of the natural attenuation at/around the 190-foot topographic contour; and 3) an evaluation/compilation of groundwater data collected during the first five years of monitoring.	Ongoing, as described below.
Natural attenuation is the remedy for low concentration contaminants remaining at DP098 after the limited soil removal is completed. USAF will monitor the actual performance of the natural attenuation remedy in accordance with the following monitoring guidelines: • Frequencies for groundwater and seep monitoring will be based on the sampling guidelines provided in the monitoring frequency decision guide from the DP098 ROD. • Surface water samples will be collected from the kettle pond annually as a point of compliance and sampled for the same sampling suite as the groundwater COCs.	Ongoing.

Table 4-13
DP098 Remedy Implementation Status (Continued)

Remedy Component	Brief Status
• The analytical testing of water samples will monitor concentrations of the COCs, daughter products, and other analytes, as appropriate. In addition, field-testing will monitor changes in site conditions. Analytes and field parameters will be measured to track changes in contaminant migration as well as to monitor the progress of natural attenuation. • Natural attenuation in soil and sediment will not be monitored prior to collecting soil confirmation samples. Confirmation sampling will be conducted to confirm effectiveness of the natural attenuation of soil and sediment only after groundwater chemical-specific ARARs have been achieved.	
After completion of the source removal, a treatability study will be undertaken in the area of the 190-foot topographic contour to evaluate the effectiveness of natural attenuation in this area. The objectives of this treatability study are: • To assess the feasibility of enhancing the natural attenuation process by evaluating the impact of adding an additional nutrient source; • To determine if this "enhanced" natural attenuation would significantly reduce the predicted cleanup time frames; • To fill data gaps from the RI and evaluate the possible presence of dense, nonaqueous phase liquids (DNAPL); and • To evaluate MNA in groundwater. Trends of decreasing COCs and predictive groundwater modeling will be used as lines of evidence to indicate that MNA is successfully remediating groundwater. The treatability study will be conducted within one year of implementing the selected remedy.	Completed in 2007. One additional treatability study occurred during this review period in 2010.
After the first five years of groundwater monitoring, USAF will evaluate the progress of MNA. This evaluation will compile, analyze, and review all data collected, including information from the Remedial Investigation/Feasibility Study, and the natural attenuation and treatability study remedy components described above. Additional groundwater modeling will be completed to provide updated estimates for the time frames to meet the cleanup goals. If during this evaluation, the data indicates contaminant concentrations in groundwater are not decreasing as estimated, USAF, EPA, and ADEC may reconsider the remedy decision. One or more of the following observations could lead to re-consideration of the remedy.	Completed in October 2008 with the submission of an evaluation/ compilation of data.

Table 4-13
DP098 Remedy Implementation Status (Continued)

Remedy Component	Brief Status
• Increase in parent contaminant concentrations indicating that other sources may be present; • Concentrations of parent contaminants and/or daughter products may indicate that the estimated cleanup time frames may not be reached; and/or • Plume of primary contaminants and/or daughter products increases significantly in areal or vertical extent and/or volume from that predicted by modeling estimates. These observations could trigger the implementation of enhanced MNA.	
The specific LUCs associated with groundwater at DP098 are as follows: • No dewatering of excavations or trenches will be allowed unless contaminated water is treated prior to use or disposal. Any excavations or drilling greater than 10 feet bgs will require engineering controls to prevent downward migration of contamination and to protect the groundwater aquifer. • The use of contaminated groundwater throughout DP098 for any purpose including, but not limited to, drinking, irrigation, fire control, dust control or any other activity, is prohibited.	Implemented in May 2002. Updated the 673d Air Base Wing Instruction 32-7003 *Land Use Control Management* in May 2011.

Note:
For definitions, see the Acronyms and Abbreviations section.

The highest levels of soil contamination encountered during the RI/FS were in the outfall area of the drain tile that extended northwest from Building 18224. Approximately 768 tons of soil was removed to the ROD-specified depth of 10 feet within a 25-foot radius of suspected location of the drain tile (USAF, 2006c). The suspected drain tile was not encountered and soil samples collected at the excavation edge were above the cleanup levels for TCE and cis-1,2-dichloroethene (DCE). TCE was detected at a maximum concentration of 3.1 milligrams per kilogram (mg/kg) and cis-1,2-DCE was detected at a maximum concentration of 9.0 mg/kg. The excavation was backfilled with clean material.

DP098 data gaps were addressed through field investigations. In October 2007, the subsurface was profiled to 85 feet bgs using a membrane-interface probe to detect any DNAPL that might have migrated to the bottom of the shallow aquifer (USAF, 2008f). Results of this investigation showed some chlorinated solvent contamination may be present at the base of the aquifer.

Groundwater monitoring at DP098 began in 1997. The groundwater monitoring plan is updated annually in accordance with the monitoring frequency decision guide (Appendix F, Figure F-2) to ensure that the program remains comprehensive and protective. Historical data concerning the number of wells/seeps water points sampled annually at DP098 are provided in Appendix H.

Several updates were made to monitoring frequency; since 2007 the monitoring program included monitoring 11 wells: 7 annually, 3 every two years and 1 every five years. The purpose for monitoring at DP098 is to assess contaminant migration and the timely reduction of contaminant concentrations by natural attenuation and enhanced attenuation. Figure C-22 in Appendix C presents the key well concentrations of PCE, TCE and cis-1,2-DCE, over time. Trend analysis using composite data generally confirm that the natural attenuation components of the DP098 remedy are performing as originally envisioned (USAF, 2012a).

In 2007, groundwater samples were analyzed for DRO and GRO (which are contaminants of potential concern [COPC], but not COCs for DP098) to help evaluate the contribution of petroleum compounds on the natural attenuation of the chlorinated solvent COCs

(USAF, 2008a). These analyses indicated that DRO at 41755WL-02 has been depleted. Data from subsequent monitoring indicate that reductive dechlorination of PCE and TCE appears to have stalled at cis-1,2-DCE at this location due to carbon limitation and insufficiently reducing geochemical conditions. An evaluation of the progress of natural attenuation was required by the ROD once groundwater data had been collected for five years. This evaluation was completed in 2008 (USAF, 2008b) and data suggested that carbon amendment may be necessary to promote reductive dechlorination.

Subsequent monitoring and data analysis show that PCE and TCE are reduced to cis-1,2-DCE, but detection of vinyl chloride (indicative of further dechlorination of cis-1,2-DCE) is mostly limited to the center of the plume (USAF, 2012b). At this time, trend analysis indicates there has not been an overall reduction in total COCs and it is not possible to predict a cleanup time for DP098. Additional monitoring is necessary to determine at what rate cis-1,2-DCE and vinyl chloride concentrations will continue to decrease once TCE has fully degraded.

Two treatability studies were completed based on the objectives outlined in the ROD as presented in Table 4-13: one in 2005 (USAF, 2009a) and another in 2010 (USAF, 2012d):

- In July 2005, approximately 2,300 gallons of a vegetable oil-in-water emulsion followed by a sodium lactate solution push of approximately 1,000 gallons were injected into three wells in the shallow aquifer at DP098. Results indicate that concentrations of TCE decreased to nondetect in the injection area for the first 14 months of monitoring. Concentrations of cis-1,2-DCE (an intermediate degradation product of TCE) increased by more than double in the 10-month sampling event, and then decreased by approximately 10 to 30 percent between the 10- and 14-month sampling events. The reductive dechlorination process is limited by the low population of microbes and their slow growth rate at cold groundwater temperatures.
- In May 2010, a technology demonstration of biogeochemical transformation of chlorinated solvents in groundwater occurred at DP098. Subsurface injections into three treatment cells compared the effectiveness of a commercially available product EHC® to emulsified vegetable oil augmented with various forms of sulfate. Groundwater monitoring occurred over a 15-month period following the injections. The *Biogeochemical Transformation of Chlorinated Solvents at the DP098 Site* (USAF, 2012d) concluded that technology demonstration was able to reduce concentrations of TCE and PCE in the treatment cells. However, the study was not able to achieve complete reduction of chloroethenes, resulting in increased levels of vinyl chloride in two of the test cells. The other test cell (#2) did not see an increase in vinyl

chloride, but the expected formation of reduced iron sulfide mineral did not progress as expected. Although each treatment had some success, no treatment was clearly superior to the others for enhancing bioremediation at DP098. Additional investigation of the effects of groundwater flow and mixing on iron and sulfate availability and improvements on the distribution methods and timing would be needed to implement any of these technologies onsite.

LUCs have been established and are being maintained to prevent exposure until cleanup levels are attained (see Section 4.7). In general LUCs listed in the DP098 ROD limit excavating, digging, and drilling in certain areas, limit the use of contaminated groundwater throughout the site, and maintain the current land use. Results of annual LUC inspections, conducted to ensure compliance with LUCs, are documented in annual monitoring reports (USAF, 2013).

4.6.2 DP098 Systems Operations and Maintenance

The estimated annual O&M costs for DP098, as presented in the ROD, totaled $120,000/year for the first five years of groundwater monitoring. Annual ongoing LUC management costs include site inspections, photographic documentation, and reporting. With the exception of 2012, annual O&M costs for DP098 have generally decreased since 2008. Historical O&M costs associated with DP098 are provided in Appendix H.

4.7 LAND-USE CONTROLS

JBER-E has established LUCs (formerly referred to as institutional controls) to limit exposure to contaminated soil and/or groundwater. LUCs are maintained until contaminant concentrations in the soil and groundwater decrease to levels that allow for UU/UE. The LUCs at JBER-E include restrictions on the use of the shallow aquifer, limitations on the types of buildings at specific areas, and designations of specific areas for certain uses only.

LUCs were established for OUs 1, 2, 4, 5, and 6 and DP098 in their respective RODs (USAF, 1994a [OU1], 1995b [OU2], 1995a [OU4], 1995c [OU5], 1997e [OU6], 2004a [DP098]), as a component of their selected remedies, as described in the previous sections. Implementation of LUCs was clarified in a memorandum to the site file for OU1 (USAF, 1997a), and the clarified language is provided in Table 4-14. On October 7, 2003, the

Secretary of the Air Force established a USAF *Policy on Performance-Based RODs for LUC Implementation*, which outlined specific LUC provisions to be included in Air Force RODs. These provisions were included in the DP098 ROD (USAF, 2004a) and incorporated into the other OU6 remedies though the OU6 ESD (USAF, 2007b).

While the Air Force policy provides guidance on specifying how LUCs are implemented, it does not change the nature of the LUCs as adopted by the RODs. JBER-E currently implements LUCs through 673d Air Base Wing Instruction 32-7003 (USAF, 2011d [19 May]). From 1997 until 2011, 3 WGI 32-7003 was the guidance document for LUCs at JBER-E. Prior to 1997, LUCs were implemented through a Land-Use Controls Management Plan. LUCs are also included in the Base General Plan, and locations and descriptions of the LUCs are included as a layer in GeoBase, which is a Basewide geographical information system.

Some minor variances in LUC language between the Base General Plan, 3 WGI 32-7003, the 2008 five-year review (USAF, 2008a), and the most recent governing documents (RODs) have been noted for OUs 1, 2, 4, and 5. The most recent LUC language has been captured in a memorandum to the site file which brought the RODs for those OUs into conformance with the USAF *Policy on Performance-Based RODs for LUC Implementation*; this document has been added to the Administrative Record (USAF, 2010a). The clarified language is also included in Table 4-14.

LUC boundaries for active CERCLA sites are shown on Figure A-2 in Appendix A, and dates that LUCs were implemented at each OU are included in Table 2-1. Note that Appendix A, Figure A-2 does not show groundwater LUC boundaries for OU5 because the OU5 LUCs are implemented through a Basewide groundwater use restriction. The most up-to-date LUC descriptions are provided to JBER-E personnel in an annual ERP Atlas. Current LUCs, as described in the 2012 atlas (USAF, 2012c), are presented in Table 4-14.

Table 4-14
Land-Use Controls for Operable Units 1, 2, 4, 5, 6, and DP098

OU (Site)	Land-Use Control Description[1]	Expected Year of LUC Expiration[2]
1 (LF059)	OU1 is currently designated as an "Outdoor Recreational Use Area." Land-use and water use controls specifically aimed at restricting use of the shallow aquifer at Site LF059 will be maintained. These controls will remain in effect as long as USAF maintains active control of the area or until the groundwater contamination dissipates to such levels that will no longer pose any unacceptable human health or environmental risks. The specific controls to be implemented and/or maintained at Site LF059 are as follows: • Development of a site zoning map showing areas currently and potentially impacted by groundwater contaminants; • Zoning the affected areas for undeveloped outdoor/recreational use only; • Continued enforcement of Base policy prohibiting installation of groundwater wells (other than for monitoring purposes) into the shallow aquifer underlying LF059; and • Securing of existing water supply and groundwater monitoring wells. • Excavating, digging, or drilling into the area is restricted under the Base General Plan and to reduce the possibility of migration or uncontrolled exposure to contaminants that exceed the chemical-specific ARAR or subsurface debris.	2033
2 (ST041)	Land-use and water use controls that restrict access to groundwater and groundwater development at Site ST041 will be maintained as long as hazardous substances remain on the site at levels that preclude unrestricted use. In addition, deed restrictions or equivalent safeguards will be implemented in the event property containing groundwater contamination is transferred by USAF. The specific controls to be implemented and/or maintained at Site ST041 are as follows: • The development of a site zoning map showing areas currently and potentially impacted by groundwater contaminants; • Zoning the affected areas for industrial use only, excluding the development of commercial aquaculture; • Prohibiting installation of groundwater wells (other than for monitoring purposes) into the shallow aquifer underlying OU 2; and	2018

Table 4-14
Land-Use Controls (LUC) for Operable Units 1, 2, 4, 5, 6, and DP098 (Continued)

OU (Site)	Land-Use Control Description[1]	Expected Year of LUC Expiration[2]
	• Prohibiting unauthorized access to existing water supply and groundwater monitoring wells.	
4 (FT023, SD024, SD025, SD028, SD029)	OU 4 is designated for “Airfield Use Area” for aircraft O&M, to include active and inactive runways, taxiways, and parking aprons for aircraft. Access to the contaminated groundwater and shallow soils throughout OU4 will be restricted until cleanup levels have been achieved.	2026
5 (ST037)	Institutional controls on land use and water use restrictions will restrict access to the contaminated groundwater throughout OU5 until cleanup levels have been achieved.	2028
6 (LF002)	Access to soil at LF002 will be institutionally controlled. LF002 is currently designated as a “restricted use area” in the Base General Plan. This designation provides for recreational use of the parcel (e.g. cross-country skiing) and for construction of unmanned facilities such as a parking lot, storage building, or taxiway, but prohibits the construction of any sort of manned facility such as an office building or residence. Drilling into the shallow aquifer is also restricted by the Base General Plan to prohibit residential or agricultural use of contaminated groundwater.	Indefinite
6 (LF003)	Access to groundwater and soil at LF003 will be institutionally controlled. LF003 is currently designated as a “restricted use area” in the Base General Plan. This designation provides for a recreational use of the parcel (cross-country skiing) and for construction of unmanned facilities such as a parking lot, storage building, or taxiway, but prohibits the construction of any sort of manned facility such as an office building or a residence. Drilling into the shallow aquifer is also restricted by the Base General Plan to prohibit residential or agricultural use of contaminated groundwater.	Indefinite
6 (LF004)	Access to groundwater at LF004 South will be institutionally controlled. LF004 is currently designated as a “restricted use area” in the Base General Plan. This designation provides for recreational use of the parcel (e.g., cross-country skiing) and for construction of unmanned facilities such as a parking lot, storage building, or taxiway, but prohibits the construction of any sort of manned facility such as an office building or a residence.	Indefinite

Table 4-14
Land-Use Controls (LUC) for Operable Units 1, 2, 4, 5, 6, and DP098 (Continued)

OU (Site)	Land-Use Control Description[1]	Expected Year of LUC Expiration[2]
	Drilling into the shallow aquifer is also restricted by the Base General Plan to prohibit residential or agricultural use of contaminated groundwater. **Groundwater at LF004 South** LUCs will restrict access to groundwater at LF004 South. Drilling into the shallow aquifer is also restricted by the Base General Plan. **Soil at LF004 North/Beach** LUCs will restrict access to soil at LF004 North/Beach.	
6 (SD015)	The land use designation for Site SD015 is “Industrial Area” in the Base General Plan. Land use and water use controls, as specified in the Base General Plan, will restrict access to the contaminated perched aquifer groundwater throughout Site SD015. Installation of wells in the contaminated plume for residential, industrial, or agricultural use will be prohibited by the Base General Plan until cleanup levels have been achieved.	2015*
6 (WP014)	Institutional controls on land use and water use, as specified in the Base General Plan, will restrict access to the contaminated groundwater throughout WP014. Installation of wells in the contaminated plume for residential, industrial, and agricultural use will be prohibited by the Base General Plan.	2020
(DP098)	There are four types of current land use designations in the vicinity of DP098 according to the Base General Plan: “Industrial,” “Administrative,” “Open Space,” and “Outdoor Recreation.” The specific land use and water use controls at DP098 are as follows: • Excavating, digging or drilling into the area is restricted to reduce the possibility of migration or exposure to contaminants that exceed the chemical-specific ARARs. If contaminated soil that exceeds the chemical-specific ARARs is excavated, it cannot be transported to or disposed of at another location on base. Excavated soil will be transported to a disposal facility in the lower 48 states that is acceptable for disposal of CERCLA waste under the Offsite Disposal Rule (40 CFR 300.440). • No dewatering of excavations or trenches will be allowed unless the water is treated prior to disposal.	2075

Table 4-14
Land-Use Controls (LUC) for Operable Units 1, 2, 4, 5, 6, and DP098 (Continued)

OU (Site)	Land-Use Control Description[1]	Expected Year of LUC Expiration[2]
	• Any excavations or drilling greater than 10 feet bgs will require engineering controls to prevent downward migration of contamination and to protect the groundwater aquifer; • The use of contaminated groundwater, throughout DP098, for any purpose including, but not limited to, drinking, irrigation, fire control, dust control, or any other activity is prohibited. • The current land use will be maintained to reduce the possibility of exposure to contaminants.	

Notes:
[1] LUC descriptions were obtained directly from the 2012 ERP Atlas.
[2] Expected year of LUC expiration are listed in the Base General Plan.
* The Base General Plan lists the expected year of LUC expiration for SD015 as “to be determined.” The 2015 date for expected LUC expiration was taken from OU6 ESD (USAF, 2007a).
For definitions, see the Acronyms and Abbreviations section.

In addition to the site-specific restrictions outlined in the various RODs and described in Table 4-14, JBER-E has implemented an administrative restriction on the use of groundwater from the shallow aquifer. The installation manages this restriction using the 673d Air Base Wing Instruction 32-7003 *Land Use Control Management* (USAF, 2011a). Portions of the shallow aquifer are contaminated and may pose a health risk. Therefore, use of the shallow aquifer within the groundwater control boundary for any purpose including, but not limited to, drinking, irrigation, fire control, dust control, or any other activity is strictly prohibited. The shallow aquifer is defined as any unconfined, saturated, water-bearing zone below the ground surface. The groundwater control boundary is south of the Elmendorf Moraine and is documented in the 2012 ERP Atlas, which is updated annually (USAF, 2012c); it is also located on the JBER GeoBase webpage.

Contaminated groundwater seeps flow from the southern boundary of JBER-Elmendorf at OU5 (ST037) and landfill debris erodes from a landfill located on the western boundary of JBER-Elmendorf at OU6 (LF004). In 1996, JBER acquired a lease from the Alaska Railroad to contain and mitigate off-base contamination from OU5 through the use of an engineered wetland system that was built on this leased property. The lease will terminate in 2026. It is anticipated that the wetland remediation system at OU5 will be decommissioned prior to 2026. In addition, the USAF is currently exploring an optimized exit strategy for OU5 to meet cleanup goals prior to the end of the property lease.

No off-base contamination exists at LF004 where a portion of LF004 adjoins the expanded Port of Anchorage facilities (Figure A-3, Appendix A). The expanded port facilities are outside of the JBER-Elmendorf LF004 boundary. The expanded port facilities have not affected the remedial activities at LF004 and have not resulted in increased exposure to contaminants. JBER continues to coordinate closely with the Port of Anchorage to ensure the debris removal is conducted annually.

LUCs are implemented, managed, and enforced by offices within the 673 CES at JBER-E, as summarized below:

- The Real Property office ensures that LUCs are incorporated into all real estate instruments such as property leases, property transfers, tenant support agreements, permits, easements, and right-of-ways.
- The Community Planning office oversees base development, including initial planning and facility siting, preparation of construction contract documents, project design review, and project execution. Community Planning ensures that LUCs are incorporated into the Base General Plan and all new development projects. A Base Civil Engineer Work Request (Air Force Form 332) is required for the initial siting or planning of all projects at JBER-E. AF Form 332 describes the project in detail, including the type and location of work to be performed, whether digging or trenching will be conducted, and which base organization is responsible for the work. Community Planning coordinates reviews of AF Form 332 with Environmental Restoration if the project is in an area with LUCs. LUC boundaries are recorded in GeoBase and available for viewing through the JBER-E intranet.
- Program managers and contracting officers incorporate general LUC language into all programming and contract documents regarding LUC restrictions and required actions. The program manager or contracting officer may coordinate these documents with the Environmental Restoration Office to determine whether site-specific LUC language needs to be added prior to finalizing the construction or contracting document.
- The Environmental Restoration Office reviews all Work Clearance Requests (also known as “dig permits”) to ensure compliance with the LUCs. A dig permit (673d Air Base Wing Instruction 32-1007, AF Form 3 [JBER-E] or AF Form 4 [JBER-R]) must be prepared and coordinated for all projects executed at JER-E in which there is a ground disturbance of more than 4 inches below the ground surface (USAF, 2011a). This includes small construction that does not go through the Community Planning process. If a project

requires excavation in a LUC area, the dig permit informs the requestor about the potential for contaminated groundwater or soil, as well as the requirements for handling contamination if any is encountered. The Dig Permit also requires the requestor to avoid damaging monitoring wells or any other components of the remedy.

LUC site inspections are performed annually to ensure that LUCs are being followed, including checking for any needed maintenance for access controls and evidence of unauthorized wells or disturbance. Results of annual inspections are recorded in annual monitoring reports. The Environmental Restoration Office submits an annual report to the regulators that identifies compliance/non-compliance with LUCs.

LUCs continue to remain protective and are functioning as intended by the decision documents. The protectiveness of each remedy is described in detail in Section 7.0. Additional LUCs are not required at this time.

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5.0 PROGRESS SINCE THE LAST REVIEW

5.1 PROTECTIVENESS STATEMENTS FROM LAST FIVE-YEAR REVIEW

The *Third Five-Year Review* (USAF 2008a) developed the following protectiveness statements in accordance with EPA guidance (EPA, 2001) for each OU where a remedial action has been initiated.

Operable Unit 1: The remedy at OU1 is expected to be protective of human health and the environment upon attainment of groundwater cleanup levels at one remaining site (LF059). In the interim, exposure pathways that could result in unacceptable risks are being controlled.

Operable Unit 2: The remedy at OU2 is expected to be protective of human health and the environment upon attainment of groundwater cleanup levels through natural attenuation at ST041. In the interim, exposure pathways that could result in unacceptable risks are being controlled.

Operable Unit 4: The remedy at OU4 is expected to be protective of human health and the environment upon attainment of deep soil cleanup levels through bioventing at one remaining site (FT023) and attainment of groundwater cleanup levels through natural attenuation at sites FT023, SD024, SD025, and SD029. In the interim, exposure pathways that could result in unacceptable risks are being controlled.

The remedy at site SD028 is protective of human health and the environment. Groundwater samples from the time of the ROD show that no contamination above background levels/regulatory cleanup levels remains and the site is acceptable for UU/UE.

Operable Unit 5: The remedy at OU5 is expected to be protective of human health and the environment upon attainment of groundwater and seep cleanup levels through natural attenuation, capture and treatment of contaminated seeps, and confirmation through sentry and early warning well monitoring networks that the point of compliance at Ship Creek is not impacted by OU5 contaminants. In the interim, exposure pathways that could result in unacceptable risks are being controlled.

Operable Unit 6: The remedy at OU6 is expected to be protective of human health and the environment for all sites. The remedy at LF004 North is expected to be protective of human health and the environment through the annual removal of exposed landfill debris. The remedies at LF004 South, WP014, and SD015 are expected to be protective of human health and the environment upon attainment of groundwater cleanup goals through natural attenuation. In the interim, exposure pathways that could result in unacceptable risks are being controlled.

DP098: The remedy at DP098 is expected to be protective of human health and the environment upon completion. In the interim, exposure pathways that could result in unacceptable risks are being controlled.

5.2 FOLLOW-UP ACTIONS FROM LAST FIVE-YEAR REVIEW

The 2008 five-year review (USAF, 2008a) identified six issues and provided recommendations for follow-up actions. None of the issues affected the current protectiveness in 2008 or the future protectiveness. Progress on the 2008 issues and recommendations is summarized in Table 5-1. Several recommendations to optimize the remedy and/or minimize unnecessary costs were also included in the 2008 five-year review. Progress on these recommendations is also included in Table 5-1.

Table 5-1
Progress on Follow-Up Actions Identified in the Last Five-Year Review

Issues from Previous Review	Recommendations/Follow-up Action	Party Responsible	Milestone Date	Action Taken and Outcome	Date of Action
OU1 (LF059) Upgradient Plume (no impact to protectiveness). The TCE plume at LF059 appears to be originating, at least in part, from the upgradient OU1 landfills. There are insufficient data to determine the impact to long-term groundwater quality and the estimated cleanup date at LF059.	Incorporate data from upgradient wells LF05GW-2B and OU1LF-19 into evaluation of natural attenuation and analysis of contaminant trends, and update the conceptual site model for the TCE plume at LF059.	USAF	2010	The USAF commissioned two evaluations during the review period. The first evaluation consisted of a corrective measures study for the LF007 permitted landfill and the second evaluation consisted of a conceptual site model update for Site LF059. *The Landfill Correction Measures Study* report (USAF, 2009) concluded that landfill gas from LF007 is likely a source of groundwater VOCs, particularly TCE, found downgradient of the landfill. The LF059 Field Investigations and *Conceptual Site Model Update* Report (USAF, 2010) concluded that no residual source of TCE was found in the vadose zone within the LF059 site boundary and that an upgradient source of TCE was affecting the groundwater flowing into the site and incorporated data from OU1LF-19 as part of the evaluation.	April 2009 July 2010
OU2 (ST041) Surface Water (no impact to protectiveness). The surface water point of compliance (SW-13) in the center of the wetland area was not monitored between 2003 and 2007 due to confusion over its location. The location of point of compliance was re-established and surface water was sampled in 2008. The 2008 results demonstrate that surface water contaminants attenuate between contaminated seep ST41-SP01 and the surface water point of compliance. Annual sampling is needed to demonstrate protectiveness.	Monitor the surface water point of compliance (SW-13) annually and seep ST41 SP01 every five years to assess the natural attenuation remedy for OU2 surface water. Document these updates to the OU2 monitoring program in a memorandum to the site file.	USAF	2009	Submitted Memorandum to the Site File. The point of compliance is monitored annually.	March 2011
OU4 (FT023, SD024, and SD025) Inconsistent Cleanup Levels (no impact to protectiveness). The cleanup levels for 1,2-dichloroethane, PCE, and TCE for FT023 groundwater, and DRO and GRO for SD024 and SD025 soil, as presented in OU4 ROD, are inconsistent with their referenced standards. The cleanup levels for 1,2-dichloroethane, PCE and TCE at FT023 are listed as 6 µg/L instead of the MCL standard of 5 µ g/L. The cleanup levels identified for DRO and GRO at SD024 and SD025 are 1,000 and 2,000 mg/kg respectively, which is the reverse of their referenced Alaska Cleanup Matrix Level D standard. These inconsistencies appear to be typographical errors because there is no discussion in the ROD about deviation from the referenced standards.	Update the ROD-specified cleanup levels for 1,2-dichloroethane, PCE, and TCE for FT023 groundwater, and DRO and GRO for SD024 and SD025 groundwater, so that they are consistent with their referenced standards. Document the updated cleanup levels in a memorandum to the site file.	USAF	2009	Submitted Memorandum to the Site File	February 2010

Table 5-1
Progress on Follow-Up Actions Identified in the Last Five-Year Review (Continued)

Issues from Previous Review	Recommendations/Follow-up Action	Party Responsible	Milestone Date	Action Taken and Outcome	Date of Action
OU5 (ST037) Fairchild Avenue Plume Downgradient Boundary (no impact to protectiveness). The downgradient extent of the Fairchild Avenue Plume is delineated at the water table but not in wells screened deeper in the shallow aquifer. TCE has not been detected in downgradient seeps, downgradient early warning/sentry wells, or in Ship Creek, but was detected in a downgradient Alaska Railroad Corporation well in 2002.	Define the downgradient limit of the Fairchild Avenue Plume in the deeper portions of the shallow aquifer.	USAF	2010	Plume and source area investigation activities occurred at OU5 in 2010; however, the downgradient limit of the Fairchild Avenue Plume in the deeper portions of the shallow aquifer was not fully delineated. Therefore, a recommendation to utilize the findings in the *ST37 TCE Plume and Source Area Investigation Report* and continue to delineate the plume boundaries and source areas at OU5 is included in the Summary Form and Table 9-1 of this five-year review.	2010
OU5 (ST037) Contaminated Seep (no impact to protectiveness). In 2005 and 2006, the TCE concentration in Seep 7 (OU5SP-07) increased to just above the cleanup level. The decision guide for re-starting an existing seep collection area or adding a new seep collection area for treatment (Appendix F, Figure F-4) indicates that the response for this seep should be quarterly monitoring.	Increase the monitoring frequency for Seep 7 to quarterly in accordance with the decision guide in the 2005 OU5 memorandum to the site file.	USAF	2009	The monitoring frequency was increased to quarterly in accordance with the decision guide in the 2005 OU5 memorandum to the site file.	2009
OU2, 4, 5 and 6 (ST041, SD025, ST037, WP014, LF004, and SD015) Cleanup Schedules (no impact to protectiveness). Monitoring shows that the natural attenuation remedies are generally decreasing COC concentrations. At several sites, the process is slower than anticipated in the ROD. For most of the affected sites, the slower attenuation rates are limited to a few individual wells or just a few additional years until cleanup goals are met. The slower rates of natural attenuation have the largest effect at OU5, where natural attenuation may take several additional decades to reach cleanup levels. OU5 has a large monitoring program and a relatively expensive treatment system for contaminants discharging at seeps, so the impact on cleanup costs could be significant. In the interim, LUCs are in place to ensure protectiveness.	Continue monitoring until cleanup levels are met. Continue to use trend analysis to evaluate the natural attenuation remedies. Adjust estimated dates for achieving groundwater cleanup in accordance with trend projections. For OU5, attempt to identify sources of TCE contamination for Fairchild Avenue, OU5MW-02, SP1-02, Kenney Avenue, and Slammer Avenue Plumes. If sources can be identified, evaluate alternative remedial strategies to accelerate attainment of the TCE cleanup level in OU5 groundwater. LUCs will remain in place to ensure protectiveness until cleanup goals are met.	USAF	2013	Monitoring will continue to occur until cleanup levels are met at OU2, OU4, OU5, and OU6. However, cleanup dates for several sites cannot be predicted at this time based on either stable or increasing trends at various wells at the affected sites. Investigation activities to identify plume boundaries and sources of TCE at OU5 are described in detail in the *ST37 TCE Plume and Source Area Investigation Report* (included as Appendix I).	Ongoing

Table 5-1
Progress on Follow-Up Actions Identified in the Last Five-Year Review (Continued)

Issues from Previous Review	Recommendations/Follow-up Action	Party Responsible	Milestone Date	Action Taken and Outcome	Date of Action
N/A	**OU2 (ST041) No impact to protectiveness.** Incorporate wells ST41-28 (North Plume) and ST41-16 (South Plume) back into the monitoring program for OU2 when free product is no longer present in these wells. These wells have historically had some of the highest COC concentrations and are important for trend analysis estimates for meeting cleanup levels. Reduce sampling frequency or eliminate well ST41-07 because cleanup levels appear to be met at this location. Document sampling frequency of seeps (every five years) versus surface water point of compliance (annually) in a memorandum to site file.	USAF	When free product is absent, 2009	Monitoring wells ST41-28 (North Plume) and ST41-16 were re-incorporated back into the monitoring program for OU2 in 2009; both wells are to be sampled on an annual basis. Monitoring well ST41-07 was decommissioned in 2009. A memorandum was submitted to site file in 2011, documenting the sampling frequency of seeps versus the surface water point of compliance.	2009/2011
N/A	**OU4 (FT023) No impact to protectiveness.** Conduct soil sampling in 2010 or earlier. If soil meets cleanup levels, prepare a memorandum to the site file, shut down the bioventing system, and remove bioventing components.	USAF	2010	The system at FT023 was shut down in June 2009 so that subsurface soil samples could be collected. Results indicated that DRO concentrations were below cleanup levels and the soil remedy at FT023 was complete. Most of the components of the bioventing system were decommissioned in October 2009 and final decommissioning was completed in December 2010. The decommissioning and removal of the bioventing system is described in detail in the *2009 Zone 2 Management Area Annual Report* (USAF. 2010c).	2010
N/A	**OU4 (SD024 and SD029) No impact to protectiveness.** Increase monitoring frequency of wells OU4MW-04 and IS6-01 to annually document attainment of cleanup levels and expedite closure of these sites.	USAF	2009	The monitoring frequency was increased for wells OU4MW-04 and IS6-01. Samples collected from monitoring well OU4MW-04 have exhibited concentrations of COCs below cleanup levels from 2010-2012, and SD024 is recommended for a Cleanup Complete determination. Additionally, only concentrations of TCE at monitoring well IS6-01 slightly exceed the cleanup level, indicating that the increased monitoring frequency should continue to expedite closure of SD029.	2008

Table 5-1
Progress on Follow-Up Actions Identified in the Last Five-Year Review (Continued)

Issues from Previous Review	Recommendations/Follow-up Action	Party Responsible	Milestone Date	Action Taken and Outcome	Date of Action
N/A	**OU4 (SD028) No impact to protectiveness.** Prepare a Site Closure report documenting that groundwater meets cleanup levels at SD028 and recommend a Cleanup Complete determination for this site.	USAF	2009	An additional monitoring well (SD28MW-01) was installed at the site in 2011 to confirm or refute the presence of COCs in the groundwater. Samples collected from the well in 2011 exhibited non-detectable concentrations of COCs. A recommendation is provided in Table 9-2 of this five-year report stating that if two consecutive rounds of sampling indicate groundwater is below cleanup levels identified in the ROD, the USAF will request no further remedial action for groundwater.	Ongoing
N/A	**OU5 (ST037) No impact to protectiveness.** Re-sample well OU3MW-25 (OU3MW-25 Plume) to confirm that TCE concentration remains below the cleanup level. If confirmed, prepare memorandum to site file to document that sampling for this plume should be discontinued.	USAF	2009	Concentrations of TCE were below cleanup levels from 2007 through 2009, which was sufficient to demonstrate that cleanup levels in groundwater had been achieved for the OU3MW-25 Plume; the well was subsequently removed from the sampling program in 2010. A 2010 plume and source area investigation indicates that monitoring well OU3MW-25 may actually define the boundary of the Combined Fairchild Plume which would consist of the northern portion of the Fairchild Avenue, Plume, the OU3MW-25 Plume, and the OU5MW-02 Plume.	2010
N/A	**OU5 (ST037) No impact to protectiveness.** Optimize early warning and sentry monitoring well networks to eliminate wells that are not downgradient of plumes and consider additional wells where there is a greater probability of contaminant migration.	USAF	2010	The early warning and sentry monitoring well network has not yet been optimized based on this recommendation. The recommendation is restated in Table 9-2 of this five-year report.	Ongoing
N/A	**OU5 (ST037) No impact to protectiveness.** High O&M costs for the wetland remediation system are attributed primarily to the moving parts (pumping systems). Evaluate the feasibility of shutting down pump stations. Pump Station #2 can be mothballed in accordance with the decision guide for shutting down pumping stations because Seep 3 (OU5SP-03) has met cleanup levels for the past five years. Seep 1 may be diverted from Pump Station 1 since it has also met cleanup levels for the past five years. This would leave only Seep 2 discharging to Pump Station #1, which would then only have to operate at a fraction of its current flow rate. These alternatives, if determined to be feasible, could be implemented through a memorandum to the site file.	USAF	2011	An Optimization Study was performed to determine whether the wetland remediation system could be utilized as a passive system. As part of Phases I and II of the Optimization Study, the overland flow cell was not re-started following the winter of 2008-2009, and Pump Stations #1 and #2 were shut down. The results of Phases I and II of the Optimization Study indicated that COC degradation within the two seep collection areas serviced by Pump Stations #1 and #2 was sufficient to achieve applicable cleanup standards within the seep collection areas prior to discharge from those areas. Phase III of the Optimization Study was performed from October 19, 2009 through May 3, 2010, and included weekly inspections of the Wetland Treatment Cell and monthly monitoring of discharge points for the Wetland Treatment Cell (WCSW-02) and the Pump Station #1 seep collection area (OU5CP-01). The results of Phase III, described in an addendum to the Optimization Study report (USAF, 2011) were generally consistent with the results of Phases I and II, with the exception that modifications to the configuration of the	2011

Table 5-1
Progress on Follow-Up Actions Identified in the Last Five-Year Review (Continued)

Issues from Previous Review	Recommendations/Follow-up Action	Party Responsible	Milestone Date	Action Taken and Outcome	Date of Action
				Pump Station #1 seep collection area were examined to 1) increase the retention time of COCs from seep OU5SP02 in the collection area, and 2) maintain the water level within the collection area at an elevation below ground level. Design modifications included installation of baffles in the seep collection area to control water flow and increase retention time, and planting native vegetation to enhance natural contaminant degradation processes. Results of the Phase III evaluation were presented in the *Zone 3 Management Area Wetland Remediation System Optimization Study Addendum* (USAF, 2010b). Analytical data collected at wetland remediation system discharge points confirmed that COCs in wetland remediation system influent were effectively treated when the system was operated passively. The USAF, EPA, and ADEC agreed to continue passive operation of the wetland remediation system in the 2011 OU5 Memorandum to the Site File (USAF, 2011c) for a non-significant change to the OU5 ROD that formally changed the OU5 wetland remediation system treatment approach from an active (i.e., pumping) to a passive system.	
N/A	**OU5 (ST037) No impact to protectiveness.** Evaluate the feasibility of alternatives to the wetland remediation system for treating contaminated seeps. The wetland remediation system was designed to treat petroleum contaminants. Although it is also effective at treating the current TCE contamination, it is not very efficient. Seep 2 (OU5SP-02) is collected in a lined, gravel filled drain, and most of the contaminants at the seep appear to volatilize or biodegrade as water flows from the seep to Pump Station #1. The magnitude of the dilution effect of mixing clean water from Seep 1 with contaminated water from Seep 2 is unknown. If contaminant treatment in the lined drain can be confirmed, similarly constructed lined drains may be able to treat contaminants in other seeps (Seeps 7, 9, 10, and 11) in a passive (i.e., no pumping) treatment system with a much smaller footprint than the current wetland remediation system. This alternative, if feasible, would likely require an ESD or ROD amendment to be implemented.	USAF	2011	The wetland remediation system treatment approach was changed from active to passive based on the findings of an Optimization Study performed for ST037 from 2008 through 2010.	2011

Table 5-1
Progress on Follow-Up Actions Identified in the Last Five-Year Review (Continued)

Issues from Previous Review	Recommendations/Follow-up Action	Party Responsible	Milestone Date	Action Taken and Outcome	Date of Action
N/A	**OU6 (LF002) No impact to protectiveness.** Sample LF002 groundwater for all COPCs for one sample round. If LF002 groundwater meets all cleanup levels, prepare a site closure report to document Cleanup Complete for LF002.	USAF	2010	Groundwater sampling for all COPCs was completed in 2009. Additional sampling for DRO, GRO was completed in 2010 and 2011. Sampling for TAH and TAqH was initiated in 2010 and will be completed in 2013.	2009
N/A	**OU6 (LF004) No impact to protectiveness.** Conduct groundwater monitoring and evaluations in the context of LF004 South requirements of the OU6 ROD. Sample well OU6MW-61 to determine whether LF004 South groundwater meets cleanup levels for chlorinated solvent COCs.	USAF	2010	Changes made to the 2010 sampling program incorporate recommendations from the 2008 five-year review and align the monitoring activities to the OU6 ROD. OU6MW-61 and chlorinated solvents were added to sampling program.	2010
N/A	**OU6 (WP014) No impact to protectiveness.** Incorporate well OU6MW-77 back into the monitoring program for WP014 once free product is no longer present in the well. This well has historically had some of the highest COC concentrations and is important for trend analysis estimates for meeting cleanup levels.	USAF	When free product is absent	Changes made to the 2010 sampling program incorporate recommendations from the 2008 five-year review and align the monitoring activities to the OU6 ROD. As of 2011, free product is still present at OU6MW-77.	NA
N/A	**(DP098) No impact to protectiveness.** Increase the sampling frequency of Well 41755WL-08, located in the smaller COC plume, to twice annually. The DP098 ROD requires this frequency of monitoring if wells are upgradient of a receptor and COC concentrations are increasing. Sample surface water in the vicinity of Well 41755WL-08 concurrently with groundwater samples.	USAF	2010	Samples were collected at 41755WL-08 twice in 2009, annually thereafter. Samples were collected at surface water location DP98SW-03 once in 2010.	2009
N/A	**(DP098) No impact to protectiveness.** Prepare a Remedial Action report now that all components of the remedy are implemented.	USAF	2009	The *DP098 Remedial Action Report* was submitted, approved and finalized.	September 2009
N/A	**OU1, 2, 4, and 5, no impact to protectiveness.** Update the documentation of LUC implementation in a memorandum to the site file to comply with USAF policy.	USAF	2009	Submitted Memorandum to the Site File	February 2010

Note:
For definitions, see the Acronyms and Abbreviations section.

6.0 FIVE-YEAR REVIEW PROCESS

This five-year review was conducted using the following EPA guidelines:

- EPA *Five-Year Review Guidance* (EPA, 2001)
- *Clarifying the Use of Protectiveness Determinations for CERCLA Five-Year Reviews* (Memorandum dated September 13, 2012; EPA OSWER publication number 9200.2-111)
- *Assessing Protectiveness at Sites for Vapor Intrusion* (Document dated November 2012; EPA OSWER publication number 9200.2-84)
- EPA Five-Year Review Summary Form Template (EPA, 2011)

6.1 ADMINISTRATIVE COMPONENTS

The USAF, lead agency for the JBER-E ERP, notified potentially interested parties to the occurrence of the review using newspaper notices, emails, and distribution of a fact sheet (described in Section 6.2) in fall 2012.

The five-year review team consisted of individuals from Environmental Restoration (673 CES), Public Affairs (673 WG/PA), and the Air Force Legal Operations Agency – Judge Advocate Civil Engineer (AFLOA/JACE). Technical support was provided by support contractors to 673 CES that had conducted recent O&M activities associated with the remedies at each site. Therefore, in addition to USAF personnel, these O&M site managers and staff were offered the opportunity to participate in interviews.

The schedule of this five-year review extended from July 2012 through signature of the final report in March 2014. The five-year review included the following components: document reviews, site inspection, interviews with community members and contractor O&M personnel, an assessment of protectiveness of the remedies, community notification and involvement, and development of this Five-Year Review Report. Documentation of the inspections is located in Appendix D. Interview documentation is included in Appendix E.

6.2 COMMUNITY NOTIFICATION AND INVOLVEMENT

The community was notified of, and given opportunity to have input on, the five-year review. A fact sheet was distributed to Community Environmental Board members and mailed to interested parties of the local community, regulators, contractors, Port of Anchorage, and the Alaska Railroad. Copies were also supplied to the Alaska Resources Library and Information Service, which is the physical information repository. The general public was notified of the five-year review with public notices placed in the *Anchorage Daily News* on August 18 and 19, 2012 and in the *Eagle River Alaska Star* on August 23, 2012.

Public comments and input on the protectiveness of the JBER-E remedies were solicited from the community through email questionnaires. Questionnaires were emailed to 18 stakeholders in August 2012, including interested parties of the local community, regulators, contractors, the Port of Anchorage, and the Alaska Railroad Corporation. The fact sheet distributed in August 2012 and newspaper public notices published in August 2012 also invited the general public to request and respond to the questionnaire. The Public Notice and questionnaire responses are provided in Appendix E.

Following USAF signature of the final review and regulatory concurrence, a second fact sheet describing the findings of the review will be distributed in combination with the results of the JBER-R five-year review, which was completed in February 2013. A copy of this Five-Year Review Report will be added to the official Administrative Record.

6.3 DOCUMENT REVIEW

The RODs associated with each OU and DP098, along with updates to those RODs as documented in memoranda to site files or ESDs were reviewed to identify RAOs, contaminants of potential concern (COPCs), COCs, and cleanup levels.

The potential for changes to standards identified as ARARs in the ROD, newly promulgated standards, and/or changes to “to be considered” (TBC) identified in the ROD, to affect the protectiveness of the remedies are evaluated in Appendix B and discussed for each OU in Section 7.0. The following documents were reviewed for updates to ARARs, TBCs, and new toxicity information:

- ADEC 18 AAC 70, *Water Quality Standards*, amended as of April 8, 2012
- ADEC 18 AAC 75, *Oil and Other Hazardous Substances Pollution Control*, amended as of April 8, 2012 This will include the new cleanup levels given in Table B1 (Method Two), and Table C.
- ADEC 18 AAC 80, *Drinking Water*, amended as of August 2012
- ADEC Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances, amended as of December 12, 2008
- ADEC *Cleanup Levels Guidance*, amended as of June 2008
- ADEC *Cumulative Risk Guidance*, Division of Spill Prevention and Response Contaminated Sites Remediation Program, June 9, 2008
- ADEC *Regulatory Approach to Managing Contamination in Hydrologically Connected Groundwater and Surface Water,* Technical Memorandum 01-005, April 13, 2011
- ADEC *Environmental Laboratory Data and Quality Assurance Requirements,* Technical Memorandum, March 2009
- ADEC *Vapor Intrusion Guidance for Contaminated Sites*, amended as of October 2012
- EPA 2011 Edition of the *Drinking Water Standards and Health Advisories*, amended as of 2006
- EPA 40 CFR § 141 Subpart G, *National Revised Primary Drinking Water Regulations: Maximum Contaminant Levels and Maximum Residual Disinfection Levels*, amended as of July 1, 2012
- EPA 40 CFR § 131.36 *Surface Water Toxicity*, amended as of July 2010
- EPA *OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)*, November 2002, EPA530-D-02-004
- EPA *OEA Recommendations Regarding Trichloroethylene Toxicity in Human Health Risk Assessments*, December 13, 2012
- EPA *Assessing Protectiveness at Sites for Vapor Intrusion: Supplement to the "Comprehensive Five-Year Review Guidance*", OSWER Directive 9200.2-84, November 2012
- EPA. Integrated Risk Information System (IRIS). Retrieved from http://www.epa.gov/IRIS/, October 2013

- EPA *Regions 3, 6, and 9: Regional Screening Levels for Chemical Contaminants at Superfund Sites*, May 2013
- NOAA (National Oceanic and Atmospheric Administration) 73 FR 62919, *Endangered and Threatened Species; Endangered Status for the Cook Inlet Beluga Whale*, October 22, 2008

In addition to the documents mentioned above, the following documents were also reviewed to assess the protectiveness of the remedies:

- RI/FS reports (when necessary to clarify information in the RODs);
- Remedial Process Optimization reports; and
- Annual monitoring reports.

Key documents utilized during this five-year review are listed in Section 12.0 of this report.

6.4 DATA REVIEW

Contaminant monitoring results from groundwater monitoring wells, seeps, surface water sampling locations, and soil samples were reviewed for this five-year review. Natural attenuation indicator parameter results were also reviewed when available. Field measured natural attenuation parameters (odor, sheen, temperature, turbidity, pH, DO, ORP, and conductivity) were routinely monitored for at each sampling event to assess MNA. Data collected and reported under the ERP was the primary source of information utilized in the data review in addition to supplemental information collected under Environmental Compliance Program. All relevant data from the Environmental Restoration Sites, regardless of the environmental mandate, are evaluated annually by JBER-E to assess progress of the ROD-selected remedies. Specific information pertaining to monitoring wells, including well screening depths, is presented in the annual ERP Atlas (USAF, 2012c). It is noted that monitoring well label designators included in Section 6.4 and on the figures provided in Appendix C may not be reflective of the areas that they monitor.

Data collected through the 2012 sampling events were evaluated in the *2011 Zones 1, 2, and 3 Annual Report*, (USAF, 2012b) and the *2012 Annual Monitoring Report for CERCLA Sites* (USAF, 2013). The evaluation included statistical analysis to determine when contaminant concentrations exhibited statistically significant trends and, when possible, provided an estimation of when COCs are expected to meet cleanup levels. This assisted in determining whether sites are on track to meet cleanup levels by the ROD-specified completion dates.

For the purpose of this review, Mann-Kendall trend analysis was used to evaluate trends in groundwater concentration data for all sites. The Mann-Kendall nonparametric test for trends (Gilbert, 1987) can determine whether contaminant concentrations have no trend, or whether they are significantly increasing or decreasing with time. This test is well suited for environmental data because it requires only small sample sizes (at least four data points) and does not assume any underlying distribution for the data. Trends were identified as “decreasing” or “increasing” if the significance of Mann-Kendall test was at least 95 percent, otherwise trends were classified as “no trend.” A “no trend” determination may imply that the plume is stable.

In the *2011 Zones 1, 2, and 3 Annual Report* (USAF, 2012b), natural attenuation was evaluated through time-series plots of contaminant concentrations and the statistical geometric regression approach, described in detail in the *2007 Remedial Process Optimization Report* (USAF, 2008d). This algorithm finds the best-fit, first-order decay curve via regression (linear regression of the logarithms of contaminant concentrations versus time). The standard error of regression, which reflects the degree of scatter in the data about the decay curve, is used to calculate the 95-percent confidence interval (termed the 1.96 standard deviation envelope in the 2007 *Remedial Process Optimization Report*). This interval represents the best estimate of limits that will bracket 95 percent of historical and future observations and has a 95-percent probability of encompassing the true decay curve, assuming that a first-order decay model is appropriate and that plume dynamics are constant over time. This model accounts for uncertainty in the data but does not account for uncertainty in the decay curve itself. The intercept of the upper confidence interval with the cleanup level is the estimated cleanup date.

Data, and the trend analyses, are discussed for individual OUs below. To simplify the discussion of whether sites are on track to meet cleanup levels by the ROD-specified completion dates, trend analysis results from the *Zones 1, 2, and 3 Annual Report* (USAF, 2012b) is discussed in terms whether COCs at a monitoring location are:

- Below the cleanup level;
- On track to reach the reach the cleanup level by the ROD-specified completion date;
- Decreasing, but predicted to reach the cleanup level after the ROD-specified completion date;
- Increasing trend; or
- No identifiable trend.

If a site has more than one COC, the monitoring location is considered to exhibit the trend of the COC that is predicted to take the longest time to reach its cleanup goal. A more detailed presentation of data, discussion of results, and recommendations can be found in the *2012 Annual Monitoring Report for CERCLA Sites* (USAF, 2013). Monitoring results for primary COCs are presented in Appendix C. Monitoring wells are present at several sites that are not sampled as part of the IRP. The wells are identified on the figures as "non-program" wells. Monitoring wells that are sampled as part of the IRP are identified on the figures as "programs" wells.

6.4.1 Operable Unit 1

The remedy at OU1 is monitoring and LUCs at the one remaining site, LF059 (ongoing). TCE in groundwater is the only COC that is present above its cleanup level at OU1; historical COC results are included in Figure C-1 (Appendix C). Two wells (LF59MW-02 and LF59MW-03) were monitored under the CERCLA program at OU1 during this review period. As recommended in the *Third Five-Year Review Report* (USAF, 2008a), compliance monitoring results from upgradient wells LF05GW-2B and OU1LF-19 were also considered when evaluating the effectiveness of the remedy at LF059.

Biogeochemical parameters measured over the past five years indicate that site conditions are weakly anaerobic to weakly aerobic and, therefore, not conducive to significant reductive dechlorination. It is expected that cleanup goals at the site will occur due to other natural attenuation process including dispersion, adsorption, and dilution (USAF, 2012b).

LF59MW-02 and LF59MW-03 contained TCE concentrations above the ROD-established cleanup level for all monitoring events. The plume appears to be stable and the Mann-Kendall evaluation did not find statistical evidence of an identifiable trend for TCE; therefore, a time to achieve cleanup goals cannot be predicted with certainty. TCE concentrations at LF05GW-2B have fluctuated slightly near the cleanup level since 2008. Concentrations of TCE have exceeded the cleanup level at monitoring well OU1LF-19 since 2006; with exception of the fourth quarter 2011 sampling event. Mann-Kendall trend analysis indicates no identifiable trend in TCE concentrations at LF05GW-2B; however, a decreasing trend was identified for monitoring well OU1LF-19.

Additional investigation activities were conducted in 2010 as recommended in the *Third Five-Year Review Report* (USAF, 2008a). The investigation concluded that residual vadose zone sources of TCE are not present at the LF059 site and detections of TCE in the groundwater at monitoring wells LF59MW-02 and LF59MW-03 are the result of an upgradient source. Additionally, 1,1,2,2-PCA is migrating with TCE to LF059 and was also present in LF59MW-02 and LF59MW-03 above the ADEC cleanup level at the time of the study. Based on the results of the investigation activities, a TCE plume that appears to originate at or near LF007 may be the source of contamination at LF059.

6.4.2 Operable Unit 2

The selected remedy at OU2 is source removal (completed), operation of a free-product recovery system (completed), natural attenuation of contaminants in groundwater (ongoing), long-term monitoring of residual contamination in groundwater and surface water until cleanup levels are achieved in 21 years or less (ongoing), and LUCs (ongoing). The free-product recovery system operated as designed and was shut down in April 1999 after no significant recoverable quantities of free product were observed for over a year (refer to Section 4.2.1). After 1999, hand-bailing methods were used to recover remaining small quantities of floating free product at wells with more than 0.1 foot thickness. Free product detected in OU2 wells has been less than 0.1 foot thick since 2003, with the exception of ST41-25, where free-product thickness measured 0.15 feet in 2009.

Two petroleum hydrocarbon plumes exist in groundwater at ST041 and are in proximity to the complex lithographic zone of the Elmendorf Moraine (Appendix C, Figure C-2). The apparent groundwater flow associated with the ST041 North Plume is oriented northwest while the groundwater flow associated with the ST041 South Plume is oriented southwest. Groundwater and surface water data collected from 1996 through 2011 have verified that natural attenuation is occurring in both plumes at ST041.

The OU2 ROD identified BTEX as groundwater COCs at ST041, but concentrations of xylenes have been below cleanup levels since 1996. The OU2 ROD identified only benzene, toluene, and ethylbenzene as the surface water COCs. Additionally, the sum of benzene, toluene, and ethylbenzene results must also be below the cleanup level (10 µg/L) to meet SWQC for TAH as stated in Section 10.2.2 of the OU2 ROD.

At the ST041 North Plume, COC concentrations are generally decreasing. Although ethylbenzene concentrations hovered around cleanup level at the time of the 2008 five-year review (USAF, 2008a), it was below the cleanup level from 2009 to 2012. Groundwater cleanup at the site is now driven by benzene at ST41-28 (North Plume), ST41-25 (South Plume), and ST41-16 (South Plume). The downgradient point of compliance (ST41SW-13) remains free of contamination. Historical sampling results for OU2 are presented in Appendix C, Figure C-2.

Contamination levels at monitoring well ST41-28 continue to decrease (Figure C-2). Geometric regression of the benzene results for ST41-28 predicts cleanup in 2091. The correlation coefficient was 0.86 in 2011, which allows for reasonable predictive confidence, but does still represent some variability. Concentrations of ethylbenzene have been decreasing steadily since 1999 and have been below cleanup levels during the last four rounds of sampling from 2009 through 2012. Even with the relatively high variability and lower predictive ability (r^2 of 0.48), ethylbenzene levels were predicted below the cleanup level in 2009. Monitoring results collected since 2009 confirm this prediction. Overall, cleanup predictions for the monitoring wells at ST041 North Plume vary, but the COCs are generally exhibiting a decreasing trend.

Natural attenuation parameters measured in the North Plume indicate that background geochemical conditions (outside of the wetland) are conducive to biodegradation of dissolved COCs at the fringes of the plume, attenuating the COCs as they are transported by flowing groundwater. However, such attenuation is unable to prevent benzene and TAH exceedances at the seep ST41SP-01. Continued sampling of the wells, seep, and surface water are needed in order to track remedial progress and to refine the cleanup prediction. The ST041 North Plume is unlikely to reach the cleanup goal by 2016 as predicted in the OU2 ROD.

At the South Plume, upgradient monitoring well (ST41-07) was decommissioned in 2009 because the protective casing required repair and the trailing edge of the plume had migrated downgradient of this well by 2007; as evidenced by the non-detectable concentrations of benzene in samples collected from the well in 2002 and 2007. Based on the aforementioned non-detections, the 2008 five-year review (USAF, 2008a) recommended that sampling be eliminated or reduced for monitoring well ST41-07. Thus, monitoring well ST41-16 was sampled to help define the plume's northern boundary. This well contained 0.08 feet of free product in 2007 and 0.15 feet of free product in 2009. No free product was detected in 2010 or 2011. Concentrations of benzene, ethylbenzene, and toluene have exceeded the cleanup levels in this monitoring well in every monitoring event since 1992 and, although they exhibit a decreasing trend, concentrations continue to greatly exceed the cleanup levels (Appendix G). The downgradient monitoring well (ST41-25) has exhibited decreasing trends for all COCs since 2001, with only benzene remaining above its cleanup level; toluene and ethylbenzene are both well below their cleanup levels (USAF, 2012b). Thus, cleanup in this monitoring well will be governed by the rate of attenuation of benzene.

A geometric regression of benzene results for monitoring well ST41-25 shows a decreasing trend in benzene concentrations. Although the best-fit regression line of the data shows a slight decrease from 1999 to the present, the high degree of variability about the best-fit line (r^2 of 0.28) does not allow for confident predictions of future concentrations of benzene or when cleanup levels might be reached. No data were collected between 2002 and 2006, which increases the difficulty in predicting cleanup for this dataset. The samples collected in 2010 and 2011 confirm the observed decreasing trend, but remain well above the cleanup level. The shallow slope of the upper confidence interval does not allow for prediction of cleanup. The scatter in the data likely reflects the sporadic occurrence of product droplets or emulsion in the water samples from this monitoring well. Relatively immobile droplets of residual product are likely present in the smear zone near upgradient monitoring well ST41-16.

Natural attenuation parameters for both plumes indicate that anaerobic conditions persist within the plume, suggesting that biodegradation is not occurring at a significant rate. Dissolved oxygen levels continue to be negligible and oxygen reduction potential measurements indicate reducing conditions, which reflect the depletion of energetic electron acceptors. Methane levels measured in 2006 were substantial, indicating that some biodegradation via methanogenesis had been occurring. Methanogenesis is a relatively slow process, however, and is not likely to remediate the contaminated smear zones within a reasonable timeframe. Instead, the contaminated smear zones are conceptualized as attenuating primarily through dissolution in groundwater and aerobic biodegradation around the plumes' margins. Natural attenuation parameters show that background geochemical conditions outside of the plumes' margins are conducive to biodegradation of dissolved COCs, allowing for attenuation of COCs at the plume fringes as they are transported by flowing groundwater. In both plumes, groundwater contamination will persist until residual product in the smear zone is depleted. No changes in the sampling program are recommended at this time.

6.4.3 Operable Unit 4

Open sites remaining at OU4 include FT023 (a former fire training area) and SD024, SD025, SD028, and SD029 (former maintenance facilities). The selected remedy for soil at OU4 includes bioventing for deep soil and LUCs for shallow soil; both shallow and deep soils have met cleanup levels at all OU4 sites (USAF, 1998g). Additionally, all active treatment systems at OU4 have been shut down and decommissioned. Cleanup objectives for deep soils identified in the OU4 ROD have been achieved at FT023 within the last five years (USAF, 2012b).

The selected remedy for groundwater at OU4 includes groundwater monitoring to evaluate for natural attenuation of contaminants and LUCs. Benzene, toluene, PCE, and TCE are the primary COCs that continue to remain above cleanup levels in groundwater at OU4. Historical sampling results for OU4 are presented in Appendix C, Figures C-3 through C-7. Trend analysis performed for COCs at OU4 indicated generally decreasing trends at FT023 and SD029; previous trend analysis predictions determined that concentrations of COCs would reach cleanup levels by 2009 (USAF, 2008a). While decreasing trends have been identified at FT023 and SD029, concentrations of contaminants continue to remain above their established cleanup levels. From 2009 through 2011, monitoring well FP-56, located within the Northern Fire Training Area Plume at FT023, exhibited three consecutive years of COC concentrations below their established cleanup levels (USAF, 2013). For this reason, monitoring well FP-56 was removed from the annual monitoring program and the groundwater remedy for the Northern Fire Training Area is considered complete (USAF, 2013).

Groundwater contamination at the Southern Fire Training Area at FT023 is evaluated via monitoring wells 407MW-01, OU4W-11, and GW-5A. Monitoring well 407MW-01 has never exhibited concentrations of COCs exceeding their established cleanup levels. Additionally, decreasing trends for TCE, PCE, and cis-1,2-DCE have been identified at monitoring well OU4W-11; however, concentrations of COCs continue to remain above their respective cleanup levels. A trend analysis performed for monitoring well GW-5A determined that no identifiable trend was available for TCE, the only COC identified above cleanup levels. A concentration of TCE at 29 µg/L was exhibited by a sample collected from monitoring well GW-5A in 2009; the last time the well was last sampled (USAF, 2013).

Monitoring well IS6-01 results are used to evaluate contaminant concentrations at SD029. According to trend analysis performed for monitoring well IS6-01, decreasing trends have been established for TCE and PCE at the site. Concentrations of TCE continue to remain slightly above the established cleanup level of 5 µg/L, but concentrations of PCE have been below the established cleanup level of 5 µg/L since 2008.

Samples collected during the last three monitoring events (2010 through 2012) at SD024 have exhibited concentrations of COCs below their respective cleanup levels. The groundwater remedy at SD024 is considered complete and a Cleanup Complete determination is recommended for the site.

At SD028, non-detectable concentrations of COCs were exhibited by samples collected from monitoring well IS5-01 from 1988 to 1993. Therefore, this well was subsequently abandoned. Monitoring well SD28MW-01 was installed at the site in 2011 to evaluate for concentrations of COCs remaining in the groundwater. Samples collected from SD28 MW-11 exhibited non-detectable concentrations of COCs (PCE and TCE). Additional sampling is recommended at SD028 to ensure that two consecutive rounds of clean groundwater samples are collected prior to requesting a status of no further remedial action for groundwater.

At SD025, two monitoring wells (OU4W-08R and 421MW-01) evaluate progress toward achieving groundwater cleanup levels. Concentrations of COCs (toluene, benzene, and ethylbenzene) at SD025 continue to remain above their respective cleanup levels. A trend analysis evaluation determined that there is no identifiable trend for toluene and benzene; an increasing trend was identified for ethylbenzene. Samples collected in 2012 from a downgradient monitoring well (421MW-01) exhibited concentrations of COCs below their respective cleanup levels. The results from biogeochemical parameters identified at SD025 indicate an anaerobic reducing environment. Although the rate of petroleum hydrocarbon degradation under anaerobic conditions is slower than the rate typically observed in an aerobic environment, degradation of petroleum hydrocarbon constituents still occurs.

Recommendations for changes to the OU4 monitoring program include:

- Sample FT023 monitoring well GW-5A. This well has not been sampled since 2009. Because COCs in monitoring well OU4W-11 are approaching the cleanup levels, it is recommended that GW-5A be sampled again to gain understanding of how the rest of the plume is progressing.
- Evaluate alternative remedial strategies to accelerate attainment of cleanup levels in groundwater at SD025.
- Prepare a memorandum to the site file documenting that groundwater meets cleanup levels at SD024 and recommend a Cleanup Complete determination for this site.

- Conduct two rounds of groundwater sampling at SD028. If two consecutive rounds of sampling indicate groundwater is below cleanup levels identified in the ROD, the USAF will request no further remedial action for groundwater.

6.4.4 Operable Unit 5

The selected remedy at OU5 includes source removal (completed), seep water containment and treatment (ongoing), groundwater and surface water monitoring to evaluate for natural attenuation of contaminants (ongoing), and LUCs (ongoing). TCE is the primary COC that still remains above cleanup level in groundwater and surface water at OU5. TFH concentrations, monitored as TAH and TAqH, meet cleanup levels at most of the ST037 seep locations in OU5. Historical concentrations of COCs at OU5 monitoring locations are presented in Appendix C, Figures C-8 through C-17.

The point of compliance for OU5 is Ship Creek. Surface water in Ship Creek is monitored at two locations (SC-01B and SC-08) to evaluate the water quality of this receptor; COCs have never been detected in surface water samples collected from Ship Creek. Additionally, the effluent of the wetland remediation system and Beaver Pond are also monitored to provide additional protection to Ship Creek. To ensure that contamination identified within the OU5 groundwater plumes does not negatively affect Ship Creek, two lines of monitoring wells (early warning wells and sentry wells) located between the plumes and the point of compliance are sampled on a regular basis. All effluent monitoring results from the wetland remediation system and Beaver Pond and all early warning and sentry groundwater monitoring results for COCs have been below cleanup levels (USAF, 2013).

As established in the 2008 five-year review, several early warning (OU5MW-05, 76WL-01, and OU5MW-11) and sentry (OU5MW-09, OU5MW-10, 401WL-04, and 401WL-03) wells are not located downgradient of an identified groundwater plume. Geostatistical analysis performed in 2007 (USAF, 2008) concluded that there is a low probability of TCE exceeding cleanup levels in these areas; therefore, it is recommended that the early warning and sentry monitoring well network be optimized.

With the exception of sentry wells NS3-02 and OU5MW-31, the majority of sentry and early warning wells have exhibited either minimal or non-detectable concentrations of TCE. Historical samples collected from sentry wells NS3-02 and OU5MW-31 have exhibited concentrations of TCE slightly below the established cleanup level of 5 µg/L (USAF, 2008a). However, while concentrations of TCE exhibited by samples collected from the aforementioned monitoring wells have fluctuated near the established cleanup level, no exceedances have occurred since 1988 (USAF, 2012b).

Concentrations of TCE at the Fairchild Avenue Plume are currently evaluated by the following monitoring wells: 49WL-01, OU3MW-05, OU3MW-11, OU5MW-34, OU5MW-38, OU5MW-39, OU5MW-43, and OU5MW-46. Decreasing trends of TCE have been identified at in-plume monitoring wells 49WL-01, OU3MW-11, and OU5MW-34. However, an increasing trend was identified for monitoring well, OU5MW-38; which is the southernmost (downgradient) in-plume well. Concentrations of TCE continue to remain above the established cleanup level in the in-plume monitoring wells.

The *Third Five-Year Review Report* (USAF, 2008a) stated that the downgradient extent of the Fairchild Avenue Plume was undefined based on the lack of a downgradient monitoring well that was screened deeper in the shallow aquifer and based on concentration of TCE identified downgradient of the plume during the 2002 ARRC groundwater investigation (USAF, 2008a). Plume and source area delineation activities were undertaken at OU5 in 2010 (USAF, 2011g). The lateral extents of the Fairchild Avenue Plume were generally delineated based on this investigation; however, it does not appear that the downgradient portion of the Fairchild Avenue Plume was sufficiently delineated in the deeper portion of the shallow aquifer. Additional plume and source area delineation activities, which should incorporate this data gap, are recommended to be performed at OU5.

Biogeochemical parameters measured in samples collected from monitoring wells at the Fairchild Avenue Plume indicate that conditions vary from an anaerobic (reducing) environment near the former source areas to mildly oxidizing (aerobic) conditions at downgradient locations (USAF, 2012b). The historical observation of weakly aerobic to weakly anaerobic conditions suggests that the rate of TCE degradation is very low; therefore, natural attenuation of TCE is mostly likely to occur primarily as a result of dispersion, adsorption, and/or dilution. For this reason, it appears unlikely that TCE groundwater contamination will be below cleanup levels by 2025, the cleanup date stated in the ROD.

Prior to 2010, the OU3MW-25 Plume was assessed by in-plume monitoring well OU3MW-25. However, TCE concentrations in this well were below the cleanup level of 5 µg/L from 2007 through 2009, which was sufficient to demonstrate that cleanup levels in groundwater have been achieved for the OU3MW-25 Plume. Based on these results, monitoring well OU3MW-25 was removed from the sampling program in 2010 (USAF, 2012b).

TCE concentrations at the OU5MW-02 Plume are currently evaluated via monitoring wells OU3MW-02, OU5MW-44, and early warning well OU5MW-45. TCE concentrations in monitoring well OU3MW-02 have shown a decreasing trend; no identifiable trend was identified for monitoring well OU5MW-44. Concentrations of TCE continue to remain above the established cleanup level of 5 µg/L by an order of magnitude at the in-plume monitoring wells (USAF, 2013). Early warning monitoring well OU5MW-45 has consistently exhibited non-detectable concentrations of TCE. Biogeochemical indicator parameters measured in samples collected from OU5MW-02 Plume wells suggest an environment that is weakly oxidizing. TCE does not readily degrade under oxidizing conditions, which means attainment of cleanup goals at this site will depend on other natural attenuation mechanisms including dispersion, adsorption, and dilution (USAF, 2013). For this reason, it is likely that concentrations of TCE will persist above the cleanup standard at the OU5MW-02 Plume beyond the anticipated 2025 cleanup date identified in the OU5 ROD.

A TCE plume and source area groundwater investigation conducted in 2010 for OU5 indicated that the northern portion of the Fairchild Avenue Plume, the OU3MW-25 Plume, and the OU5MW-02 Plume may all be part of a larger singular plume (the Fairchild Combined Plume). According to the investigation’s findings, the Fairchild Combined Plume may be a result of a former disposal site previously identified near the east-west runway, north of Fighter Drive and east of Fairchild Avenue. Based on TCE concentrations, an additional source area may also be present in the vicinity of monitoring well 402WL-02.

The plume and source area groundwater investigation report also suggested that based on TCE concentrations, the southern portion of the Fairchild Avenue Plume is the result of a separate source area, most likely located in the vicinity of Building 6211 (USAF, 2011g).

Monitoring well 403WL-01 and three seeps (OU5SP-09, OU5SP-10, and OU5SP-11) are utilized to evaluate TCE concentrations at the Kenney Avenue Plume. Based on statistical analysis (Mann-Kendall), a decreasing trend has been identified for monitoring well 403WL-01; however, concentrations of TCE continue to remain above the established cleanup level of 5 µg/L (USAF, 2013). Concentrations of TCE exceed the cleanup level at seeps OU5SP-10 and OU5SP-11; no identifiable trend was discernible for seeps OU5SP-10 and OU5SP-11 (Appendix G). Seeps OU5SP-10 and OU5SP-11 discharge directly into the wetland treatment cell, reducing the potential for negative effect to the point of compliance (Ship Creek). A source for the Kenney Avenue Plume was not clearly identified during the 2010 plume and source area groundwater investigation; however, the report suggests that based on TCE concentrations, a possible source area may exist in the vicinity of Building 4314 (USAF, 2011g).

Biogeochemical indicator parameters measured in samples collected from monitoring well 403WL-01 in 2011 indicate the presence of a moderately reducing (anaerobic) environment; however, prior to 2008, the environment at well 403WL-01 was more oxidizing. This change from an oxidizing to reducing environment is attributed to the effects of the enhanced bioremediation treatability study performed at the site from 2006 to 2008. Data collected from a cross-gradient monitoring well (OU5MW-36) suggests that the natural biogeochemical conditions in this area are moderately oxidizing. Therefore, TCE degradation rates outside of the bioremediation treatability study's area of influence may continue to remain low (USAF, 2013). For this reason, it is unlikely that TCE concentrations will fall below the established cleanup level by 2025, as specified in the OU5 ROD.

The Slammer Avenue Plumes are assessed via monitoring wells OU5MW-06 (western), GW-4A, OU5MW-07, and OU5MW-08 (eastern). Concentrations of TCE have consistently been below cleanup levels at monitoring wells OU5MW-08 and GW-4A, and a decreasing trend was identified for monitoring well OU5MW-06; no identifiable trend could be established for monitoring well OU5MW-07. Concentrations of TCE continue to remain above the cleanup level at monitoring wells OU5MW-06 and OU5MW-07 (USAF, 2013). Monitoring well GW-4A currently acts a downgradient monitoring well for the eastern Slammer Avenue Plume; concentrations of TCE have been below cleanup levels at this well since 2007. No monitoring wells are located at the southern extent of the western Slammer Avenue Plume; however, surface water sampling locations have been defined (BPSW-03, BPSW-04, and BPSW-05) and are sampled on a quarterly basis to determine concentrations of COCs. The point of compliance for the Slammer Avenue Plumes is the outlet of the Beaver Pond (Figure C-15). This surface water location (BPSW-01) is also sampled on a quarterly basis and results have been consistently below cleanup levels. The area in the vicinity of Building 8515 was identified as a potential source area for the western Slammer Avenue Plume; however, no specific source area for the eastern Slammer Avenue Plume was delineated during the 2010 plume and source area groundwater investigation (USAF, 2011g).

Biogeochemical indicator parameters measured in samples collected from monitoring wells at the Slammer Avenue Plumes suggest an environment that varies from oxidizing (aerobic) to reducing (anaerobic). Natural attenuation through reductive chlorination is attributed to the effective TCE degradation rates observed in monitoring wells GSW-4A and OU5MW-06; however, degradation rates have been shown to be substantially slower in the eastern plume interior as evidenced by the lack of a decreasing trend in monitoring well OU5MW-07 (USAF, 2013). For this reason, it is likely that concentrations in the eastern plume will persist above the cleanup standard beyond the anticipated 2025 cleanup date identified in the OU5 ROD.

The SP1-02 Plume is assessed annually via monitoring well SP1-02 and seep OU5SP-15. Monitoring wells OU5MW-15 and OU5MW-45 (early warning well) have also been utilized historically to delineate the lateral extent of the plume. A decreasing trend was identified at monitoring well SP1-02 and the sample collected during the August 2012 sampling event exhibited a concentration of TCE at 5.4 µg/L; only slightly exceeding the established cleanup level of 5 µg/L (USAF, 2013). Trend analysis was not performed for seep OU5SP-15 as samples have exhibited non-detectable concentrations of TCE since 2002; with the exception of June 11, 2007 when the sample result was 0.29 µg/L. Based on the decreasing trend, and the remaining concentration of TCE in monitoring well SP1-02, it appears likely that TCE concentrations will be below the cleanup standard prior to the anticipated 2025 cleanup date identified in the OU5 ROD. The 2010 plume and source area groundwater investigation indicated that it is likely that a localized source area is contributing to the identified groundwater contamination at the site (USAF, 2011g).

As described in Section 4.4.2, over the past five years, components of the wetland remediation system have been decommissioned as part of an ongoing Wetland Remediation System Optimization Study described in the *2009 Zone 2 and Zone 3 Management Areas Work Plan* (USAF, 2009c). The purpose of the Optimization Study was to evaluate whether the wetland remediation system could achieve treatment objectives established by the OU5 ROD without pump station operation. The results of Phases I and II Optimization Study are described in detail in the March 2010 *Zone 3 Management Area Wetland Remediation System Optimization Study* (USAF, 2010d) and the results of the Phase III evaluation are presented in the *Zone 3 Management Area Wetland Remediation System Optimization Study Addendum* (USAF, 2010b). The USAF, EPA, and ADEC agreed to continue passive operation of the wetland remediation system in the *OU5 Memorandum to the Site File* (USAF, 2011c) for a non-significant change to the OU5 ROD that formally changed the OU5 wetland remediation system treatment approach from an active (i.e., pumping) to a passive system.

COC concentrations in water are currently monitored within the Wetland Treatment Cell at three locations (WCSW-02, WCSW-03, and WCSW-04) and two locations at the Pump Station #1 seep collection area (OU5CP-01 and OU5CP-02) to gauge the effectiveness of the wetland remediation system. COC concentrations were also historically measured at a fourth location (WCSW-01), which was the discharge point for water entering the Wetland Treatment Cell from three pump stations. However, WCSW-01 is no longer monitored as the pump stations have not operated since 2009. With the exception of one sample result in which the TCE concentration slightly exceeded the cleanup level at WCSW-03 in January of 2012, the wetland treatment cell monitoring locations have exhibited concentrations of COCs below the established cleanup levels (USAF, 2013).

Concentrations of benzene, TAH, and TAqH exceeding cleanup levels have been consistently detected in samples collected from seeps OU5SP-01 and OU5SP-02, which are located in the vicinity of Pump Station #1. For this reason, two control points (OU5CP-01 and OU5CP-02) were established to evaluate for petroleum hydrocarbon contamination in the surface water downgradient of the seeps. With the exception of a sample collected on May 3, 2010, which exhibited a concentration of TAH at 11 µg/L, the surface water samples collected from the two control points have exhibited concentrations of contaminant constituents below cleanup levels (USAF, 2013). The lack of downgradient contamination identified in the samples collected from OU5CP-01 and OU5CP-02 indicates that the petroleum hydrocarbon contamination identified in seeps OU5SP-01 and OU5SP-02 is being effectively remediated via biodegradation. This is achieved by a biofilm that develops as a coating on the saturated gravel within the seep collection areas. For this reason, the contamination identified in samples collected from seeps OU5SP-01 and OU5SP-02 is not negatively affecting downstream receptors. The extent of the soil source area affecting groundwater and thereby contributing to the benzene and petroleum hydrocarbon contamination detected in seeps OU5SP-01 and OU5SP-02 is not well delineated.

Concentrations of TCE exceeding the established cleanup level have been continuously detected in samples collected from seep OU5SP-07. Seep 7 (OU5SP-07) is not captured by the wetland remediation system, and flow from this seep merges with the wetland remediation system effluent just downstream of the wetland remediation system discharge point. The TCE concentrations in Seep 7 are only slightly above the cleanup level, and based on concentrations in upgradient groundwater (Kenney Avenue Plume), are unlikely to increase in the future. TCE is volatile, and concentrations likely decrease to below the cleanup level within a short distance from the seep (USAF, 2013). Therefore Seep 7 (OU5SP-07) poses no significant risk to human health or the environment (i.e., Ship Creek).

Seeps on the western and central bluffs (Appendix C, Figure C-14) mark the downgradient extent of TCE contamination above the 5 µg/L cleanup level. This is confirmed by the consistent monitoring results from downgradient sentry wells OU5MW-12, OU5MW-13, and OU5MW-14 (Figure C-17). TCE concentrations in these sentry wells have usually been below detection limits and have never exceeded 0.35 µg/L during the period 2008 through 2012 (USAF, 2013).

The success of the natural attenuation remedy for groundwater at OU5 has been varied. TCE concentrations at a number of wells in the OU5 TCE plumes are either currently below the cleanup level or display a decreasing trend. However, at least one in-plume well at the Fairchild Avenue Plume, the OU5MW-02 Plume, and the Slammer Avenue Plumes, has exhibited either an increasing trend or no identifiable trend for TCE, indicating that the groundwater remedy of natural attenuation will more than likely not meet the cleanup level for TCE prior to the ROD-specified date of 2025. In addition, while the in-plume monitoring well at the Kenney Avenue Plume (403WL-01) has exhibited a decreasing trend for TCE, concentrations remain above the established cleanup level of 5 µg/L. Current trends indicate that natural attenuation processes alone are unlikely to achieve TCE cleanup levels throughout OU5 groundwater by 2025. Because contaminants in seeps are fed by groundwater, it is also unlikely that TCE will meet cleanup levels in seeps by 2025.

Recommendations for changes to the OU5 monitoring program include:

- Utilize the findings from the *ST37 TCE Plume and Source Area Investigation Report* (USAF, 2011g) to further delineate potential source areas. If the source areas can be adequately delineated, evaluate alternative remedial strategies to accelerate attainment of the TCE cleanup level in OU5 groundwater.
- Optimize the groundwater monitoring network at OU5 as recommended in the *ST37 TCE Plume and Source Area Investigation Report* (USAF, 2011g).
- Optimize early warning and sentry monitoring well network to eliminate wells that are not downgradient of plumes and consider additional wells where there is a greater probability of contaminant migration.
- Identify the extent of soil contamination that is resulting in elevated concentrations of benzene and petroleum products identified in seeps OU5SP-01 and OU5SP-02. An assessment of residual soil contamination will be needed to predict the timeframe to meet RAOs at seeps OU5SP-01 and OU5SP-02.

6.4.5 Operable Unit 6

The selected remedy at areas within OU6 includes natural attenuation of contaminants in groundwater (ongoing), LF002 surface debris removal and cover application (complete), annual LF004 debris removal (ongoing), SD015 groundwater and soil treatment via HVE (complete) and SD015 groundwater via MNA (ongoing).

Groundwater, soil, and other monitoring data were reviewed for trends and expectations of meeting cleanup levels. The most recent data and trends are documented in the 2011 and 2012 annual monitoring reports (USAF, 2012b and USAF, 2013).

Operable Unit 6 Groundwater

Overall, OU6 groundwater is progressing toward cleanup goals:

- LF002 groundwater has met cleanup goals. Surface water needs one final round of sampling in order to confirm cleanup goals have been met.
- LF004 groundwater has met cleanup goals for chlorinated compounds. Monitoring well OU6MW-63 has met cleanup goals for COCs but likely still contains fuel contamination, which potentially attributes to fluctuations in contaminant levels at the nearby seep.
- Benzene levels in OU6MW-61 at LF004 South are not decreasing.
- WP014 groundwater appears to be decreasing in the main plume but the OU6MW-46 Plume has not exhibited a decreasing trend.
- SD015 groundwater shows a decreasing trend for TCE but not for benzene.

COC concentrations in some wells might extend the estimated timeframe to meet groundwater cleanup goals for these sites. Historical sampling results for OU6 are presented in Appendix C, Figures C-18 through C-21. Groundwater monitoring data are discussed below for each of the active OU6 sites.

<u>LF002 Groundwater:</u> The only groundwater COC at LF002 was 1,1,2,2-PCA, and monitoring results are presented in Appendix C, Figure C-21. The ADEC cleanup standard for 1,1,2,2-PCA, 4 µg/L, was adopted as a cleanup level for LF002 groundwater in the 2007 OU6 ESD (USAF, 2007b). In 2007, COC concentrations across the site were determined to be less than the cleanup level. The OU6 ROD states that when this condition is reached, the final round of groundwater monitoring will include analyses for all constituents that exceeded MCLs during the 1994 investigation (USAF, 1997a). In 2009, closure sampling was conducted at the site. All results were below cleanup levels (USAF, 2013). ADEC requested

DRO and GRO analysis be added for all LF002 sampling locations prior to determining NFA is necessary for groundwater and seeps at LF002. DRO and GRO were not detected in samples collected from all four monitoring wells nor the seep for two consecutive rounds of sampling in 2010 and 2011 (USAF, 2012b). Additional fuel-related parameters for the surface water, TAH and TAqH, were not detected or were detected below their applicable standards in the seep sample in 2011 (USAF, 2012b). TAH and TAqH will need to be monitored for one more round in order to fulfill the requirement of the ROD for two consecutive sampling events with results below the RAOs.

LF004 South Groundwater: The OU6 ROD identified benzene, ethylbenzene, toluene, methylene chloride, and 1,2-dichloroethane (DCA) as COCs, and monitoring results are presented in Appendix C, Figure C-19. At the time of the ROD, fuel contaminants were found in groundwater throughout the southern part of LF004 and in seep LF04SP-02. Also at the time of the ROD, chlorinated solvents were limited to just a few monitoring wells: OU6MW-61, OU6MW-67, and OU6MW-77. Over time, groundwater monitoring for the sites in this area evolved to include wells from adjacent sites and some wells were removed from the program. In 2010, changes were made to the sampling program to incorporate recommendations from the last five-year review and align the monitoring activities to the OU6 ROD. OU6MW-61 and chlorinated solvent analytes were added back to the sampling program.

The current program consists of sampling OU6MW-61 (every five years), OU6MW-63 (every five years), and OU6MW-67 (every five years) for LF004 South COCs. Seep sampling is required for the above COCs at seeps LF04SP-02 (annual) and LF04SP-02DG (annual). Seeps LF04SP-03 and LF04SP-04 are monitored for LF004 South COCs in conjunction with WP014 COCs. Cleanup levels have been met for 1,2-DCA and methylene chloride in monitoring wells OU6MW-63, OU6MW-67, and OU6MW-77 and all seeps. However, seeps also need to be evaluated for TAH and TAqH to evaluate whether cleanup levels have been met. Seep LF04SP-02 had exhibited decreasing concentrations of benzene from 2002 through 2007 but rebounded to previous benzene and ethylbenzene concentrations in 2008 and in 2010, alternating with concentrations below cleanup levels in 2009, 2011 and 2012

(USAF, 2013). None of the chlorinated COCs were detected. A decreasing trend for fuel contaminants cannot be confirmed due to the high variability in the data. However, the downgradient seep LF04SP-02DG continues to produce results below cleanup levels for all contaminants in the sampling program.

Monitoring well OU6MW-63, located just upgradient of LF04SP-02 and the LF004 boundary, also exhibited decreasing benzene concentrations over time, and has met the benzene cleanup level since 2006. If the benzene concentrations in seep LF04SP-02 remain below the cleanup level, it would appear that groundwater in this portion of LF004 meets all OU6 cleanup levels for COCs. However, MNA field parameters in monitoring well OU6MW-63 remain characteristic of fuel contamination (no dissolved oxygen, negative oxygen reduction potential, and elevated conductivity). Additionally, the seep (LF04SP-02) has a fuel odor, and substantial iron staining is present along the entire corridor from LF04SP-02 to its downgradient sampling location (LF04SP-02DG). Based on previous cleanup predictions for DRO (USAF, 2008d), a reasonable assumption is that DRO is still present in groundwater and is responsible for these observations. LF04SP-02 will be sampled in 2013 for TAH/TAqH to determine whether fuel compounds are exceeding these surface water criteria.

No COCs exceed the cleanup level in monitoring well OU6MW-67. Benzene concentrations at this location have been below the cleanup level since 1999, and all other LF004 South COCs have been below cleanup levels since 1996. However, the MNA field parameters in OU6MW-67 remain characteristic of fuel contamination, which probably reflects the continued presence of GRO and DRO.

Monitoring well OU6MW-61 is screened in a perched aquifer. The OU6 ROD indicated that the highest levels of benzene (up to 3,400 μg/L) and 1,2-DCA (up to 38.7 μg/L) in LF004 groundwater were detected in monitoring well OU6MW-61. Both COCs exceeded their OU6 cleanup levels during the 1994 RI/FS sampling event. In 2010 and 2011, monitoring well OU6MW-61 exceeded cleanup levels for benzene, but the chlorinated COCs detected in 1994 were not present. However, it should be noted that nondetect results for 1,2-DCA and methylene chloride had limits of detection that exceeded the cleanup levels in 2011. If the cleanup levels are met for these compounds in OU6MW-61, then cleanup of all LF004 South groundwater would be complete for chlorinated COCs. Benzene concentrations are not showing a decreasing trend. Monitoring well OU6MW-61 is scheduled to be sampled in 2016.

WP014 Groundwater: The OU6 ROD identified benzene, ethylbenzene, and toluene as COCs for WP014 groundwater, and monitoring results are presented in Appendix C, Figure C-20. Two plumes (WP014 and OU6MW-46) are managed within WP014. The WP014 Plume encompasses groundwater contamination derived from WP014 and PL81. In 2010, changes were made to the sampling program to incorporate recommendations from the last five-year review and align the monitoring activities to the OU6 ROD. Groundwater sampling is required for the site COCs at groundwater monitoring wells OU6MW-46 (every 2 years), 14MW-120 (every five years), 14MW-121(every five years), OU6MW-13 (every five years), OU6MW-91(every 2 years), OU6MW-92 (annually), OU6MW-93 (annually). Seep sampling is also required for site COCs at LF04SP-03 (quarterly as of 2012) and LF04SP-04 (annually).

The monitoring results for WP014 are consistent with the plume defined in the shallow aquifer extending from the WP014 site to points of discharge at seeps LF04SP-03 and LF04SP-04. The plume is bounded on the upgradient and cross-gradient sides where contaminant concentrations remain less than cleanup levels. In the in-plume monitoring well OU6MW-92, the concentration of benzene has continued to decrease and ethylbenzene is again below the cleanup level after a spike in 2010 (USAF, 2013). The decreasing concentration of benzene is statistically significant (Appendix G). Dissolved benzene and ethylbenzene concentrations are probably maintained by the ongoing dissolution of residual product in the contaminated smear zone and will continue to be present at similar levels until the residual product attenuates and disappears.

Downgradient of this plume, COCs in seep LF04SP-04 remain below cleanup levels. However, in seep LF04SP-03, benzene concentrations have varied over time and exceeded the cleanup level in successive years warranting an increase in sampling frequency to quarterly sampling. The latest result available at the time of this review shows a benzene concentration of 2.5 µg/L, which is below the cleanup level. Overall a trend at the seep has not been established. These seeps are expected to continue to exhibit variability in benzene concentrations while the core of the WP014 Plume attenuates and possibly migrates westward. When COC concentrations are believed to be less than the cleanup level, TAH and TAqH should be analyzed to evaluate whether surface water cleanup levels have been met.

The OU6MW-46 Plume remains consistent with no identifiable trend in contaminant concentrations. Benzene and ethylbenzene continue to exceed cleanup levels. Groundwater surrounding the plume has been shown to be favorable to biodegradation. According to an October 2011 Technical Memorandum prepared by Jacobs, *Drilling in the WP014 OU6MW-46 Plume*, an attempt was made in 2010 to install a downgradient monitoring well; however, the same aquifer was not found during drilling and it was determined that OU6MW-46 is likely located within a perched aquifer. Data indicate that contamination is not migrating from the area surrounding this well and degradation is likely occurring slowly at the margins. Little biodegradation is occurring in the core of this plume. This plume did not meet cleanup goals by the target date of 2011.

<u>SD015 Groundwater:</u> The HVE system was no longer effective at removing VOCs and was shut down in 2007. The HVE and SVE systems were decommissioned in 2008 and the remedy for the perched groundwater plume was transitioned to MNA (USAF, 2007b). Currently there are two monitoring wells at the site: OU6MW-17 and OU6MW-90. Another monitoring well, OU6MW-18, was abandoned in 2011 after it was found to be unusable. Replacement of this well was attempted in 2011 but no water was encountered in the boring (USAF, 2012b).

Of the seven site COCs, only benzene and TCE remained above groundwater cleanup levels after 2007. Both benzene and TCE continue to exceed the cleanup level in monitoring well OU6MW-17 Appendix C, Figure C-18. Analysis of the trends over 23 monitoring events show a decreasing trend for TCE but there is no identifiable trend for benzene. The MNA parameters indicate that the environment at monitoring well OU6MW-17 was relatively conducive to anaerobic reductive dechlorination of TCE. Benzene, however, degrades more rapidly in an aerobic environment. Benzene and TCE were both below the cleanup level in OU6MW-90 in 2006, but TCE has increased again and slightly exceeded the cleanup level during the most recent sampling event in 2009. Monitoring well OU6MW-18 was last sampled in 2010, and concentrations of TCE also exceeded cleanup levels but benzene was below the cleanup level in 2009 and 2010. Overall, this site is neither expected to meet the projected cleanup date of 2015, nor the cleanup date predicted in 2007 for OU6MW-17 of 2023 (USAF, 2008d).

Operable Unit 6 Soil

Soil sampling data for OU6 sites LF004 and SD015 are discussed in the following paragraphs.

LF004 Soil: Debris removal was conducted annually at LF004. Since the previous five-year review in 2008, less than 1 ton of debris was removed. The average weight of debris requiring removal from 1997 through 2007 was 23.9 tons per year, but tonnage declined dramatically following expansion of the port. The average weight of debris collected from 2008 through 2012 was 0.2 tons per year, a reduction of 99 percent. Most of the waste material was nonhazardous solid waste, mainly metal, glass, and household items. The Port of Anchorage expansion project along the shoreline of LF004 appears to have reduced the exposure to tidal action thereby reducing erosion on the lower portion of the bluff. As the bluff stabilizes, there has been an overall reduction in debris recovered. Sediment samples are no longer collected because the former beach area has been filled by the Port of Anchorage expansion, as documented in the 2008 memorandum to the site file (USAF, 2008e).

Surface soil samples were last collected from LF004 North in 2007 to determine whether contaminant concentrations have changed since the ROD. Samples in 2007 were analyzed for polycyclic aromatic hydrocarbons (PAH), metals, pesticides, polychlorinated biphenyls (PCB), VOCs, semivolatile organic compounds, dioxins/furans, GRO, DRO, and residual-range organics (RRO). Of these analytes, only six VOCs were present in any sample at concentrations greater than those detected at the time of the ROD. However, the overall low concentrations and isolated nature of the detections suggests that no new release of contaminants has occurred, and that overall soil contamination levels are not increasing. Soil samples are no longer planned for collection at this site.

Since the ROD, the only change in exposure pathways at LF004 is the elimination of recreational exposure to soils and sediment due to the Port Expansion. Combined with the soil results from 2007, this information is sufficient to verify there is no increase in risk or exposure to soils since the time of the ROD.

<u>SD015 Soil:</u> Soil sampling conducted on August 9, 2005 confirmed that shallow and deep soil meet cleanup levels for all soil COCs, including GRO, DRO, and BTEX (USAF, 2006a). However, during treatment system piping excavation in 2008, fuel-contaminated soil was encountered along the south side of former concrete pad No. 2. In 2009, approximately 250 cubic yards of contaminated soil was removed from this area (USAF, 2009b). Additional investigation of the nature and extent of remaining contamination in this area was completed in 2011. DRO, GRO, and benzene were found to meet ROD-specified cleanup levels but exceeded current State of Alaska cleanup levels. TCE was not listed as a COC in the ROD but exceeds current state standards. Benzene and TCE are currently monitored in the groundwater.

Operable Unit 6 Monitoring Recommendations

Recommendations for changes to OU6 monitoring program include:

- Continue with the plan to sample LF002 and LF004 seeps for TAH and TAqH.
- Perform remedial process optimization for LF004 South, WP014, and SD015 since it does not appear that there will be sufficient progress in the timeframe established in the ROD.
- Based on the potential risk associated with the maximum concentration of 2-methylnaphthalene detected in the groundwater at WP014 during the time of the ROD, the analyte should be resampled for to determine the concentration present at the site and to determine if current concentrations present an unacceptable risk.
- Install a downgradient monitoring well at SD015 to properly delineate the site's plume boundaries.

6.4.6 DP098

The selected remedy at DP098 is source removal (completed), natural attenuation of contaminants in groundwater (ongoing), and LUCs. Groundwater and surface water data have verified that natural attenuation is occurring at DP098. A DRO plume and a chlorinated solvent plume partially overlap in groundwater at DP098. The DRO plume is presumed to be attenuating because the UST sources were removed in 1995, and there is no longer a visible sheen in the wetland (USAF, 2008g). Petroleum hydrocarbons, including DRO, were not included as COCs in the DP098 ROD, and their presence helps accelerate breakdown of chlorinated COCs by providing a carbon source to promote reductive dechlorination (USAF, 2004d). There are two chlorinated solvent plumes; the larger plume is defined by wells 41755WL-02, 41755WL-03, 41755WL-04, and 41755WL-05, and a smaller plume is defined by Monitoring Well 41755WL-08. The smaller plume is migrating slowly through Monitoring Well 41755WL-08; however, it has not yet arrived at the downgradient sentry well (41755WL-16). Historical sampling results for DP098 are presented in Appendix C, Figure C-22. Groundwater flow at DP098 is generally to the northwest.

Estimated cleanup dates for the five plume-core monitoring wells (41755WL-02, 41755WL-03, 41755WL-04, 41755WL-05, and DP98INJ-02) were calculated using a statistical geometric regression. TCE concentrations at DP98INJ-02 decreased rapidly following the injection of emulsified vegetable oil and lactate while concentrations of cis-1,2-DCE and vinyl chloride increased, providing strong evidence of reductive dechlorination (Appendix C, Figure C-22 and geometric regression shows a decreasing trend in total COCs (r^2 = 0.8). Estimated half-lives for attenuation of total COCs in groundwater wells range between 6.4 to 60.4 years, with cleanup predictions estimated to be 2160 and 2293, or unable to be predicted. Although the best-fit regression lines of the data show decreasing trends from 1999 to the present, the high degree of variability about that best-fit line (r^2 values ranging between 0.01 to 0.52) does not allow for confident predictions of future concentrations of COCs or when cleanup levels will be reached. The data sets for individual wells are also relatively small (7 to 9 points), resulting in significant sensitivity to new data.

The five groundwater COCs are TCE, PCE, cis-1,2-DCE, 1,1-DCE and vinyl chloride (USAF, 2004a). Groundwater data collected from 1997 through 2012 have verified that some COC concentrations are decreasing at DP098, through natural and enhanced reductive dechlorination in pilot study areas; however, concentrations of all of the COCs were found at the site above the cleanup levels in 2012. Historical sampling results for all COCs are presented on Appendix C, Figure C-22. Results of trend analysis for COCs are summarized in Table 6-6.

Surface water samples from the former kettle pond has not contained detectable concentrations of groundwater COCs (there are no COCs specified for surface water in the ROD) since sampling began in 2005 (USAF, 2012b).

DP098 Monitoring Recommendations

Recommendations to the DP098 monitoring program include the following change:

- Conduct sampling at DP098 for MNA parameters [nitrate/nitrite, manganese (II), iron (II), sulfate, and methane] prior to the next five-year review to identify where variably favorable conditions that support reductive dechlorination are present. Although the timeframe to meet RAOs (35 to 75 years) at DP098 are decades away, a more detailed understanding of aquifer conditions will be needed for future remedy evaluations.

6.5 SITE INSPECTION

The site inspection for this five-year review was conducted July 16 through 19, 2012, August 23, 2012, and June 10, 2013. The site inspection team consisted of USAF consultants from Jacobs Engineering Group Inc. The team visited every site. The team located, attempted to locate, and inspected actively monitored wells and looked for signs of site disturbance (such as excavations) and changes in land use from those described in decision documents. Site inspection checklists are located in Appendix D.

The site inspection results were supplemented with documentation of site inspection activities conducted by JBER-E Environmental Restoration Contractors in annual reports. These inspections include periodic O&M inspections of active remediation systems as well as an annual inspection of each monitoring well in the monitoring program to identify and repair any damage, and an annual visual inspection of each OU to look for signs of any unauthorized digging or well installation.

LUCs were inspected by reviewing governing documents; interviewing JBER-E personnel associated with community planning, real estate, dig permitting, GeoBase, and the ERP

(Appendix E); inspecting dig permit documentation; and inspecting the sites. The LUC process is detailed in Section 4.7, and interviews are summarized in Section 6.6. Site conditions and inspection results as determined from the site inspection are summarized by OU (site) below:

- OU1 (LF059). All active monitoring wells were located and were in good condition. There was no evidence of unauthorized wells or site disturbance.
- OU2 (ST041). Most active monitoring wells were located except ST41-28 and ST41-30, which are located in a heavily vegetated area; the wells were subsequently located during the 2012 LUC inspection performed in conjunction with a groundwater sampling event. Monitoring well ST41-25 shows signs of frost heaving and requires maintenance; other monitoring wells were located and were in good condition. There was no evidence of unauthorized wells or site disturbance.
- OU4 (SD024, SD025, SD028 and SD029). All active monitoring wells were located and were in good condition. One new monitoring well was installed at SD028 in 2011. There was no evidence of unauthorized wells or site disturbance.
- OU4 (FT023). No land use changes have occurred at the site since the signature of the ROD. Construction of new hangars on a portion of FT023 has occurred since the time of the ROD. It is noted that vapor barriers were incorporated into the design of the hangars to control migration of VOCs into indoor air. All active monitoring wells were located and in good condition. There was no evidence of unauthorized wells or any other site disturbance.
- OU5 (ST037). The wetland remediation system and pump stations are located on the property easement purchased from the Alaska Railroad Corporation. The seeps and pump stations associated with the wetland remediation system were inspected and found to be in good condition. Pump station #1 was found to be unlocked and the seeps were not adequately labeled and demarcated. All active monitoring wells, including early warning and sentry wells, were located and in good condition. There was no evidence of unauthorized wells or any other site disturbance.
- OU6 (LF002). There was no evidence of debris extruding to the surface, or of human traffic. All active monitoring wells were located, and in good condition. There was no evidence of unauthorized wells or any other site disturbance.
- OU6 (LF003). The site is wooded and is recognizable as a landfill only due to topographic mounding. There was some evidence of littering but no evidence of debris extruding to the surface. There are partially overgrown recreational trails on the site. Given the limited amount of litter and overgrowth on the trails, human traffic appears to be light. There are no actively monitored wells at the site. There was no evidence of unauthorized wells or any other site disturbance.
- OU6 (LF004). The landfill and most of the bluff are wooded. Only a small portion of the bluff was bare, indicating possible recent sliding. Debris was visible on the bluff in small ravines, but none was observed at the base of the bluff. In 2007 and 2008, the Port of

Anchorage expanded their facilities which included filling the area along the shoreline at the base of LF004.

- The filled area covered over the former beach at the base of the bluff (location of former sediment samples). The filled area will protect the bluff from erosion previously caused by wave action during storms, reducing erosion in the future. Access to LF004 is controlled by fences and gates. The Port construction site (beyond the landfill at the base of the bluff, see Figure A-3 in Appendix A) is fenced and secured by the Port of Anchorage. Traffic on the top of the landfill is controlled by a locked gate on the only road. The gate has a sign notifying visitors to sign in/out and warning of landslides, landfill waste, and mudflats, and visitors are required to sign in and out of the site. Human traffic on the top of the landfill is generally limited to environmental contractors and staff conducting inspections or sampling activities, and volunteers for a whale-watching station at a single overlook point on the bluff. Whale-watching volunteers are instructed to stay at the whale-watching platform and not to roam the landfill or bluffs. Access controls were generally in good working order. All active monitoring wells were located and appeared to be in good condition. There was no evidence of unauthorized wells or other disturbance on the landfill itself. The area approximately 600 feet to the south of the landfill has been extensively mined for fill material to support the Port Expansion activities. The excavation was conducted outside of the LF004 and WP014 boundaries. There was no standing water in the floor of the excavation, indicating that excavations did not extend into the groundwater table.
- OU6 (WP014). All active monitoring wells were located and were in good condition. There was no evidence of unauthorized wells or site disturbance. The area to the south of the site has been extensively mined for fill material to support the Port Expansion activities, but the site area was untouched.
- OU6 (SD015). The HVE system piping and equipment were removed in 2008 after the system was shut down. During the site visit, all active monitoring wells were located and were in good condition. Access to the site is controlled by a locked gate, with a sign that contains contact information. There was no evidence of unauthorized wells or site disturbance.
- DP098. The site is located next to a secure military facility. Some wells are inside the secure area and were observed through the fence. Other wells are located in a wetlands area, and were not visited. The active monitoring wells that were inspected were in good condition. There was no evidence of unauthorized wells or any other site disturbance.

The five-year review site inspection team concluded that the CERCLA sites on JBER-E are being properly managed and maintained. LUCs appear to be properly implemented and enforced. No changes in land use were evident at the OUs and DP098. Difficult environmental conditions as evidenced by frost heaving of wells are routinely addressed through maintenance. The cleanup program has generally been highly optimized, but some opportunities still exist for the wetland remediation system, groundwater monitoring network, and the early warning and sentry monitoring locations at OU5.

6.6 INTERVIEWS

During the course of this five-year review, written interviews (in the form of questionnaires) were conducted with representatives from several agencies associated with the OUs and the individual sites located within each OU. Interview Record Forms documenting the issues relevant to the site are provided in Appendix E. The responses are summarized below:

- Mr. Louis Howard, ADEC: Mr. Howard commented that the [ERP] program at JBER is a well-run, responsive organization and believes that the site operations have had an overall positive effect on the surrounding community. He recognized that hiring freezes prevent backfilling of environmental management and key staff positions, but that the ERP should be commended for their efforts. He referenced semi-annual and remedial process optimization reports for more information about remedial action performance at individual sites. Mr. Howard stated that the Air Force monitors O&M, long-term monitoring, and LUCs. He stated that O&M changes occur regularly for a variety of reasons and that the USAF switch to Performance-Based Contracting should not affect the protectiveness or effectiveness of any remedies. Mr. Howard believes that the Performance-Based Contracting approach provides an opportunity for process optimization and innovation, which may lead to changes in remedial approach.
- Mr. Art Isham, Community Environmental Board member: Mr. Isham commented that JBER-E was doing what it could to address environmental problems within funding constraints. He said that the community is generally aware that the USAF is cleaning up past environmental problems and is very prompt in dealing with newly created or discovered environmental problems. Mr. Isham stated that the Community Environmental Board remains well-informed of all actions occurring at JBER and believes that the staff are qualified and interested addressing past and future environmental concerns.
- Mr. Christian Ryll, Alaska Railroad Corporation: Mr. Ryll stated that his overall impression of the restoration effort at JBER is that remedial actions will continue for the foreseeable future and that operations at OU5 have hindered the Alaska Railroad yard expansion. He believes that remedial activities at OU5 have changed from active to passive, stating that groundwater is no longer being pumped and that overland flow has been found to be adequate to remediate the water. Mr. Ryll expressed his belief that onsite O&M (presumably OU5) is not continuous. He understands that JBER's contractors advise the Alaska Railroad's Terminal Supervisors of onsite activities but that he is not usually advised of site inspections because JBER has direct access to the site. He stated that O&M difficulties included beaver activity (e.g., the need to coordinate with local wildlife officers to remove beavers) and Alaska Railroad access road maintenance activities.

- Mr. Bruce Henry, Parsons (former Air Force contractor): Mr. Henry stated that he believes the JBER restoration program is well-managed and that the program managers are excellent to work with. He stated that site operations have had little, if any, effect on the neighboring community and that information regarding site activities and remedial progress is available at the Resident Advisory Board meetings. He stated that there have not been any significant changes or difficulties in the O&M, although he understood that there had been efforts to optimize O&M and sampling schedules. He stated that his office had conducted annual inspections of the wetlands remediation system (OU5) and that no adverse conditions had been observed.

- Mr. Skip Koch, Weston Solutions (USAF OU5 contractor): Mr. Koch believes that JBER is doing a good job investigating and cleaning up contaminated sites and is not aware of any environmental impacts on the surrounding community. Weston proposes that annual groundwater reports be prepared for JBER. Weston performs O&M of the OU5 wetlands remediation system, visiting the site at least twice a month, performs monthly inspections of the OU1 Landfills during the growing season, and has proposed and presented briefings on the closure of the OU1 Landfills to site visitors.

- (b) (6) [redacted] General Public: (b) (6) [redacted] general impression is that JBER restoration efforts rely too heavily on natural attenuation but any effort toward environmental assessment and cleanup is positive. He regularly attends meetings and site visits to follow cleanup actions and progress and he feels well-informed. Mr. (b) (6) [redacted] stated he believed new sites have been discovered which may require changes to cleanup activity.

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7.0 TECHNICAL ASSESSMENT

The protectiveness of the remedy is analyzed in this technical assessment, which was completed by answering three questions for each OU, as described below. Answers to these questions are summarized in Table 7-1.

Question A: Is the remedy functioning as intended in the decision documents?

This question was answered by considering the remedy's implementation status (Section 4.0), available information reviewed in Section 6.0, and comparing the remedy to the requirements in the ROD. Remedial action performance, system O&M, monitoring, LUCs, and indicators of potential problems were assessed as applicable.

Question B: Are the exposure assumptions, toxicity data, cleanup levels and RAOs used at the time of the remedy selection still valid?

Question B was answered by evaluating the effects of MCL, cleanup level, or action limit changes in ARARs, TBCs, and exposure assumptions that were used at the time of remedy selection that may affect the protectiveness of the remedy. In addition, COPCs listed in the ROD were evaluated to determine whether new standards would cause additional compounds to become COCs (Appendix B).

This evaluation was completed according to the following EPA (2001) Guidance:

> *"Generally you should only consider changes in standards that were identified as ARARs in the ROD, then identify any newly promulgated standards for COPCs, and TBCs identified in the ROD that bear on the protectiveness of the remedy. As such, you should review any newly promulgated standards, including revised chemical-specific requirements (such as MCLs, ambient water quality criteria), revised action and location-specific requirements, and state standards if they were considered ARARs in the ROD. In evaluating a change in a standard that was identified as an ARAR in the ROD, or a newly promulgated standard or TBC, you should establish whether the new requirement indicates that the remedy is no longer protective."*

The evaluation of new or changed standards was accomplished by first identifying the applicable standard and then comparing to the current standard with emphasis on identifying any changes that occurred during this review period. Potential cleanup levels for COPCs identified in the ROD were compared to current applicable federal or state cleanup standards. Table B-1 in Appendix B summarizes the evaluation of COCs and COPCs.

The COCs and COPCs with new or more stringent standards were further evaluated by comparing the current applicable standard with the most recent maximum detected levels, as shown in Table B-2 in Appendix B. In most cases, particularly if a COPC was not selected as a COC, the most recent sampling event was at the time of the ROD. These cases are noted in the text. Since the source areas are not new or continuing sources of contamination, concentrations of contaminants are generally expected to decrease over time. Therefore contaminant levels from the time of the ROD result in conservative estimates of risk.

Risk calculations were performed for any compound where current maximum detected levels exceed the current applicable standard. Cancer and non-cancer hazards were calculated using toxicity values published on the EPA's Integrated Risk Information System (IRIS), when they were available. In certain cases, the ADEC-published value was used because none was available via IRIS and for 1,2-dichloroethane the oral reference dose was taken from the *Peer-Reviewed Provisional Toxicity Values* appendix (http://hhpprtv.ornl.gov/), which was updated in 2010. Calculations used the residential exposure assumptions for ingestion of groundwater specified in the State of Alaska *Risk Procedures Manual* (ADEC, 2000). Calculations were performed using Equations 1 and 2 from the ADEC *Cleanup Levels Guidance* for groundwater and surface water and Equations 3, 4, 7, and 8 for soils (ADEC, 2008). The results are presented in Appendix B, Table B-3.

Note that Equations 3 and 4 of the ADEC *Cleanup Levels Guidance* (for soils) represent the ingestion/direct contact pathway, and Equations 7 and 8 represent the inhalation pathway. The pathway equation that resulted in the most conservative cleanup level was used to estimate health risks in Appendix B, Table B-3.If an inorganic compound was determined to be within background levels in the soil and/or groundwater, background concentrations were provided within the OU and DP098 RODs.

New toxicity data that could cause additional compounds or requirements to become a potential protectiveness concern is summarized in Appendix B, Table B-4. Nine compounds (associated with one or more of the OUs) with new toxicity criteria were identified. An additional two compounds were included because the available toxicity data differs from that used to calculate risk in the previous five-year review. Table B-4 shows the evaluation of risks and hazards that were calculated for each of these compounds using ADEC methodology along with the new reference doses and cancer slope factors.

In order to evaluate whether the remedy remains protective, the risk/hazard calculations were compared to ADEC's risk management level of 1×10^{-5} for carcinogens and a hazard quotient of 1 for noncarcinogens. Discussions also note whether the risk falls within the EPA's risk management decision range of 1×10^{-4} to 1×10^{-6} for carcinogens. The results are discussed in the following subsections.

The assessment of potential vapor intrusion risk to indoor air has evolved significantly during the review period. Both State and Federal vapor intrusion guidance now require multiple lines of evidence to support assessments. Although historic vapor intrusion assessments of OU4, OU5, and DP098 found no threat to human health, additional lines of evidence may be needed to support short- and long-term protectiveness.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

This question was answered by considering significant data gaps that limit the assessment of remedy protectiveness (primarily identified during the data and document review in Section 6.0), any new or proposed rulings that could result in changes to ecological risk, and any plans for potential land use or land use changes.

During a meeting held with EPA and ADEC on January 14, 2003, USAF agreed to fund the inclusion of DRO and GRO in the groundwater monitoring program because they have been shown to be associated with non-carcinogenic human health risks since the signing of the RODs. This Agreement applies to monitoring of wells associated with fuel plumes. It was also agreed that until a decision document is signed with ADEC, concentrations will be compared to the current cleanup levels of 1,500 µg/L for DRO and 1,300 µg/L for GRO (18 AAC 75; ADEC, 2012) in annual reports and subsequent five-year reviews. The USAF was not required to add DRO and GRO as a CERCLA contaminant. Additionally, in 2008, ADEC raised the cleanup level for GRO to 2,200 µ/L as part of the update to 18 AAC 75, Table C.

Table 7-1
Summary of Site Questions

OU	Question A	Question B	Question C
OU1	Yes	Yes	No
OU2	Yes	Yes	No
OU4	Yes	Yes	No
OU5	Yes	Yes	No
OU6	Yes	Yes	No
DP098	Yes	Yes	No

7.1 OPERABLE UNIT 1

Question A: Is the remedy functioning as intended in the decision documents?

Answer: Yes.

Remedial Action Performance: At OU1 the selected remedy includes monitoring of COCs in groundwater until the groundwater no longer poses an unacceptable health risk and the implementation of LUCs to control exposure pathways to the COCs. Monitoring results indicate that TCE is the only remaining COC above its cleanup level, however, an upgradient source of TCE and 1,1,2,2-PCA is affecting LF059 groundwater. A cleanup date for TCE cannot be predicated at this time.

Systems Operations/O&M: With the exception of 2008, the annual monitoring costs at OU1 have continued to decrease. Operating procedures (in this case, monitoring), as implemented, will maintain the effectiveness of response actions.

Opportunities for Optimization: Studies conducted during the review period indicate that the majority of groundwater at the site meets RAOs. A status of "Response Complete" should be proposed for the groundwater at the site. The upgradient plume affecting LF059, that likely originates at the closed site LF007, should be properly delineated. If it is determined that LF007 is the source of the groundwater contamination impacting LF059, then the site should be reopened under the CERCLA program and the corresponding groundwater plume should be managed under that site.

Early Indicators of Potential Issues: An upgradient source of TCE and 1,1,2,2-PCA are affecting the northwest portion of LF059 groundwater.

Implementation of LUCs and Other Measures: OU1 LUCs are appropriate and properly implemented. They are effective at controlling exposure pathways. Potential receptors – personnel at JBER-E – have been made aware of LUC requirements through the 3 WGI 32-7003, the Base General Plan, the Work Clearance Request process, and GeoBase.

Question B: Are the exposure assumption, toxicity data, cleanup levels and RAOs used at the time of the remedy selection still valid?

Answer: Yes.

Changes in Standards and TBCs: The 1994 ROD identified two ARARs, the Safe Drinking Water Act and the Alaska *Oil and Other Hazardous Substances Pollution Control* (18 AAC 75). Although not identified as an ROD ARAR, surface water standards found in 18 AAC 70 Alaska Water Quality Standards, amended as of April 2012, is a TBC as surface water is present in the LF059 LUC area.

Maximum drinking water contaminant levels defined in 40 CFR 141 Subpart G have not been updated during the review period. State of Alaska regulations (18 AAC 75) and Water Quality Standards (18 AAC 70) were updated April 8, 2012. At the time of the ROD, several detected analytes were removed from the COPC list due to data quality or other issues. Analytes retained as groundwater COPCs in the ROD were compared to current cleanup levels (Appendix B, Table B-1).

New groundwater cleanup levels and/or MCLs (not addressed in the ROD or previous five-year reviews) for 1,1,2,2–tetrachloroethane, arsenic, beryllium, fluoride, methyethylketone, and nickel were identified (Appendix B, Table B-1). However, only fluoride and nickel exceeded the newly promulgated cleanup levels at the time of the ROD (Table B-2). Of the contaminants that exceeded their newly established cleanup levels, only fluoride had the potential to result in a hazard/risk level greater than the EPA risk management decision range (Table B-3); however, in both cases, the existing remedy is protective. Each of the contaminants that exceeded their newly established cleanup levels are discussed below:

- One concentration of fluoride at 5,200 µg/L was detected at the time of the ROD, which exceeds the current cleanup level of 4,000 µg/L. Because only one concentration of fluoride exceeded the hazard/risk level at the time of the ROD, it was not considered a COPC for OU1. For this reason, and because fluoride is naturally occurring, the protectiveness of the remedy is not called into question by the newly promulgated cleanup level.
- The maximum concentration of nickel (310 µg/L) reported at the time of the ROD exceeds the current cleanup level of 100 µg/L. However, the hazard/risk level calculated for nickel is the EPA risk management decision range; therefore, the protectiveness of the remedy is not called into question by the newly promulgated cleanup level.

The TBC surface water quality standards found in 18 AAC 70 will affect the future COPC evaluation of surface water seeps located in OU1 at site LF059. Surface water standards identify criteria for TAH and TAqH. TAH consists of the sum of the BTEX concentrations and TAqH consists of the sum of PAH concentrations. Although the surface water standards were discussed in the 2008 five-year review (USAF, 2008a), the discussion focused only on the TAH. The data collected at the time of the RI/FS does not have sufficiently low detection limits to evaluate TAqH at the level specified in the surface water quality standards (USAF, 1994).

Soil COPCs were also compared to current cleanup levels, with the exception of total petroleum hydrocarbons. Total petroleum hydrocarbons are currently regulated by the State of Alaska as DRO and RRO. New ADEC cleanup standards and/or MCLs (not addressed in the ROD or previous five-year reviews) have been promulgated for 15 analytes listed as COPCs in the ROD (Appendix B, Table B-1). However, only bis(2-ethylhexyl)phthalate, antimony, arsenic, barium, and cadmium exceeded their newly promulgated cleanup levels at the time of the ROD (Table B-2). Of the contaminants that exceeded their newly established cleanup levels, only arsenic had the potential to result in a hazard/risk level greater than the EPA risk management decision range (Table B-3); however, in all cases, the existing remedy is protective.

As stated above concentrations of bis(2-ethylhexyl)phthalate, antimony, barium, and cadmium at the time of the ROD exceeded the recently promulgated cleanup levels. However, the calculated hazard/risk level for each of these contaminants was below the EPA risk management decision range; therefore, the protectiveness of the remedy is not called into question by the newly promulgated cleanup level.

According to the ROD, the maximum concentration of arsenic was identified at 30.9 mg/kg; which exceeds the current cleanup level of 3.9 mg/kg. The identified concentration of arsenic has the potential to result in a hazard/risk level greater than the EPA risk management decision range. However, the concentration of arsenic identified at the time of the ROD (30.9 mg/kg) is within the normal background concentration range for soils in Alaska. For this reason, the protectiveness of the remedy is not called into question by the newly promulgated cleanup level.

<u>Changes in Exposure Pathways:</u> No changes to land use or site conditions were identified during this review period that would add or change exposure pathways identified in the risk assessment.

<u>Changes in Toxicity and Other Contaminant Characteristics:</u> Changes to OU1 COC chemical-specific toxicity information that occurred since the 2008 five-year review affect one of the OU1 COCs, TCE. The ROD-established groundwater RAO for TCE was assessed for protectiveness by applying the updated chemical-specific toxicity information and calculating the hazard quotient and cancer risk at the RAO concentration. The *ADEC Risk Assessment Procedures Manual* (ADEC, 2000) was followed for the assessment.

The assessment found that the groundwater RAO for TCE continues to be protective of human health under a residential exposure assumption. The data used to support the risk evaluation of OU1 COC cleanup levels is included in Appendix B.

Changes in Risk Assessment Methods: None.

Expected Progress toward Meeting RAOs: RAOs for groundwater appear to be making adequate progress, with the exception of the northwest portion of LF059. The remedy is unlikely to meet RAOs for the foreseeable future at the northwest portion of LF059 because an upgradient source (TCE and 1,1,2,2-PCA) is affecting monitoring data.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Answer: No.

7.2 OPERABLE UNIT 2

Question A: Is the remedy functioning as intended in the decision documents?

Answer: Yes.

Remedial Action Performance: At OU2, the ROD-selected remedy included a free-product and dissolved-phase recovery and treatment system; source removal (tanks, piping, and contaminated soil); monitoring of groundwater, seeps, and surface water to track natural attenuation progress; and the implementation of LUCs. The source removal and free-product recovery portions of the remedy were completed in 1996 and 1999 respectively; monitoring and LUCs are the only remaining active remedies at OU2.

Benzene, ethylbenzene, toluene, and TAH persist above their respective RAOs in groundwater and/or surface water (seep ST41SP-01). All other COCs met cleanup levels at locations sampled in 2012. Although concentrations of benzene are decreasing in all groundwater wells, the ROD-specified time for meeting RAOs with natural attenuation (2016) will not be met across the site.

Systems Operations/O&M: Initial monitoring costs appear to have been accurately estimated in the ROD, and these costs have decreased over time due to optimization. Operating procedures (in this case, monitoring), as implemented, will maintain the effectiveness of response actions.

Opportunities for Optimization: None.

Early Indicators of Potential Issues: The OU2 ROD identifies a contingency remedy, removal, and treatment of groundwater, if natural attenuation will not meet RAOs by 2016. The *Memorandum to the Site File: Operable Unit 2* (USAF, 2011e) clarified that the contingency remedy would be implemented only if the USAF, EPA, and ADEC determined that natural attenuation was not occurring at an acceptable rate. Benzene is not anticipated to meet the RAO specified in the ROD; however it appears to be slowly decreasing in concentration.

Implementation of LUCs and Other Measures: OU2 LUCs are appropriate and properly implemented. They are effective at preventing exposure and are expected to remain effective in the future. Contaminant levels at ST041 that exceed cleanup goals based on a UU/UE scenario are within the LUC boundary. Potential receptors – personnel at JBER-E – have been advised of LUC requirements through the 3 WGI 32-7003, the Base General Plan, the Work Clearance Request process, and GeoBase.

Question B: Are the exposure assumption, toxicity data, cleanup levels and RAOs used at the time of the remedy selection still valid?

Answer: Yes.

Changes in Standards and TBCs: The 1995 ROD identified three chemical-specific ARARs: the Safe Drinking Water Act, Alaska Oil Pollution Regulation (18 AAC 75), and Alaska Water Quality Standards (18 AAC 70).

Maximum drinking water contaminant levels defined in 40 CFR 141 Subpart G have not been updated during the review period. ADEC *Oil and Other Hazardous Substances Pollution Control* (18 AAC 75) and Water Quality Standards (18 AAC 70) were updated April 8, 2012.

Groundwater COPCs were compared to current federal and state standards. Newly promulgated cleanup levels and/or MCLs (not addressed in the ROD or previous five-year reviews) that were more stringent than at the time of the ROD or during the previous review period were identified for 2-methylnaphthalene, 4-methylphenol, chloroform, and trichlorofluoromethane (Appendix B, Table B-1). However, concentrations of 2-methylnaphthalene, 4-methylphenol, chloroform, and trichlorofluoromethane in the groundwater were below the newly established cleanup levels either at the time of the ROD or during subsequent sampling events (Table B-2); therefore, the newly promulgated cleanup levels for these contaminants do not call into question the protectiveness of the remedy.

The surface water quality standards found in 18 AAC 70 were compared to those listed in the OU2 ROD and the *Memorandum to the Site File: Operable Unit 2* (USAF, 2011e). A difference in the definition of TAH was noted between 18 AAC 70 and the memorandum to the site file. While the ADEC Water Quality Standards define TAH as the sum of BTEX, the memorandum to the site file defines TAH as the sum of benzene, toluene, and ethylbenzene. During this review period, there have not been any changes to the exposure assumptions or toxicity data for these surface water quality parameters.

In addition, concentrations of lead and manganese in the surface water at the time of the ROD exceeded their newly promulgated cleanup levels. Of these two analytes, only the calculated risk/hazard level for manganese had the potential to exceed the EPA risk management range (Appendix B, Table B-3). However, the newly established cleanup level for manganese is a Secondary Drinking Water MCL from the 18 AAC 80, which affects the aesthetic quality of drinking water. The concentration of manganese in surface water at this site was high enough to exceed the hazard index threshold of 1 for human consumption. Surface water is not used as drinking water at this site. Additionally, the manganese concentration in the surface and groundwater at this site is comparable to both contaminated and uncontaminated areas across JBER and is within the range expected in glacial soils. For these reasons, the newly promulgated cleanup level does not call into question the protectiveness of the remedy.

Changes in Exposure Pathways: No changes to land use or site conditions were identified during this review period that would add to or call into question the exposure pathways identified in the risk assessment.

Changes in Toxicity and Other Contaminant Characteristics: Notable chemicals excluded from the summary risk calculation in the OU2 risk assessment are EDB and methylene chloride. Positive detections of the chemicals were not included because toxicity values were not available at the time of the ROD. Currently the IRIS database (EPA, 2013) includes toxicity information for EDB and methylene chloride.

The remedy is considered to be protective in light of these changes as benzene continues to be the major contributor to site risk.

Changes in Risk Assessment Methods: None.

Expected Progress Toward Meeting RAOs: The remedy is generally progressing as expected. Most groundwater COCs are below RAOs with the exception of benzene. Although benzene concentrations appear to be decreasing, the rate is slower than originally anticipated.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Answer: No.

7.3 OPERABLE UNIT 4

Question A: Is the remedy functioning as intended by the decision documents?

Answer: Yes.

Remedial Action Performance: The selected remedy for soil at OU4 includes the implementation of LUCs to control exposure pathways to the COCs; bioventing to treat contamination identified in the deep soil; and the periodic monitoring of both shallow and deep soil, as long as contamination remains above the cleanup levels. Both shallow and deep soils have met cleanup levels at all OU4 sites (USAF, 1998g). Site closure deep soil sampling at SS010, SD025, and FT023 demonstrated that COC concentrations were consistently below remediation goals outlined in the ROD (USAF, 2003f, 2006b). Therefore, the bioventing systems successfully remediated contaminants at these sites as intended, and the bioventing systems have been shut down and site closure reports completed (USAF, 2003f, 2006b).

For groundwater at OU4, the major components of the selected remedy include monitoring to evaluate contaminant migration and timely reduction of contaminant concentrations by natural attenuation, and implementation of LUCs that limit exposure to water in the shallow aquifer (USAF, 1995a). The ROD indicated that all groundwater at OU4 should be below the established cleanup levels by 2008; the previous five-year review indicated that all sites, with the exception of SD025, should meet cleanup levels by 2009. Monitoring results indicate that concentrations of COCs are below cleanup levels at SD024 and SD028. Samples collected during the last three monitoring events (2010 through 2012) at SD024 have exhibited concentrations of COCs below their respective cleanup levels and elevated concentrations of COCs in the groundwater have never been identified at SD028. Generally decreasing trends have been identified at FT023 and SD029; however, sample results remain above the established cleanup levels at these sites. Natural attenuation appears to be occurring at FT023 and SD029; however, at a slower rate than anticipated in the ROD. A cleanup date for COCs at FT023 and SD029 cannot be predicted at this time.

According to monitoring results from SD025, concentrations of toluene and benzene appear to be stable and an increasing trend has been identified for ethylbenzene. Biogeochemical parameters at SD025 indicate an anaerobic reducing environment. The rate of petroleum hydrocarbon degradation is slower under anaerobic conditions; however, degradation rates for petroleum hydrocarbon constituents are often significant in anaerobic environments. A cleanup date for COCs at SD025 cannot be predicted at this time. While an increasing trend was identified for ethylbenzene at SD025, the concentrations detected appear to be within historical ranges. Therefore, the remedy appears to be functioning as envisioned, just not within the timeframe originally identified in the ROD.

Systems Operations/O&M: With the exception of 2010 through 2012, the O&M costs are reasonably close to ROD estimates for individual remedy components (USAF, 2008a). Operating procedures, as implemented, will maintain the effectiveness of response actions.

Opportunities for Optimization: According to monitoring results, COCs in groundwater are below their respective cleanup levels at SD024 and SD028. The site closure process should be initiated for SD024. Additional sampling is recommended at SD028 to ensure that two consecutive rounds of clean groundwater samples are collected prior to requesting a status of no further remedial action for groundwater.

Early Indicators of Potential Issues: According to monitoring results at SD025, an increasing trend has been identified for ethylbenzene. Additionally, trend analysis results indicate that concentrations of benzene and toluene are stable and no decreasing trend for these contaminants was evident. According to the OU4 ROD, all groundwater contamination was expected to be below established cleanup levels by 2008; no cleanup date can be predicted for groundwater at SD025.

As described in Section 7.0, the assessment of potential vapor intrusion risk to indoor air has evolved significantly during the review period. Several manned facilities are located in proximity to the VOC groundwater plumes associated with OU4. Historic vapor intrusion assessments have occurred at OU4 (USAF, 2010c); however, additional lines of evidence are needed to support short- and long-term protectiveness.

Implementation of LUCs and Other Measures: OU1 LUCs are appropriate and properly implemented. They are effective at controlling exposure pathways. Potential receptors – JBER E personnel –have been made aware of LUC requirements through the 673rd WGI 32-7003, the Base General Plan, the Work Clearance Request process, and GeoBase.

Question B: Are the exposure assumption, toxicity data, cleanup levels and RAOs used at the time of the remedy selection still valid?

Answer: Yes.

Changes in Standards and TBCs: Groundwater COPCs were compared to current federal and state standards. New groundwater cleanup levels and/or MCLs (not addressed in the ROD or previous five-year reviews) that were more stringent than at the time of the ROD or during the previous review period for 2-methylnaphthalene, 4-methylphenol, acetone, chloroethane, chloromethane, cis-1,3-dichloropropene, dieldrin, methyl ethyl ketone, phenol, and trichlorofluoromethane were identified (Appendix B, Table B-1). Concentrations of the aforementioned contaminants were below the newly established cleanup levels at the time ROD. Therefore, the newly promulgated cleanup levels do not call into question the protectiveness of the remedy.

Soil COPCs were also compared to current cleanup levels. New ADEC cleanup standards and/or MCLs (not addressed in the ROD or previous five-year reviews) have been promulgated for 33 analytes listed as COPCs in the OU4 ROD (Appendix B, Table B-1). However, only 1,1,1-trichloroethane, 2-methylnaphthalene, copper, and thallium exceeded the newly promulgated cleanup levels at the time of the ROD (Appendix B, Table B-2). Each of the contaminants and their newly promulgated soil cleanup levels are discussed below:

- According to the ROD, concentrations of metals detected at OU4 (copper, chromium, nickel, selenium, and thallium) were determined to be the result of background conditions. Therefore, the newly promulgated cleanup levels for thallium and copper do not call into question the protectiveness of the remedy.
- One concentration of 1,1,1-trichloroethane at 2.92 mg/kg was detected during the time of the ROD at the FT023 site, which exceeds the current soil cleanup level of 0.82 mg/kg. However, the calculated hazard/risk level was less than the EPA's risk management decision range (Appendix B, Table B-3). For this reason, the protectiveness of the remedy is not called into question by the newly promulgated cleanup level.
- The concentration of 2-methylnaphthalene that exceeded the cleanup level was detected at SS010, a site that has undergone bioventing and received a status of Cleanup Complete; therefore, it is unlikely that concentrations of 2-methylnaphthalene still exist at the pre-ROD levels. Additionally, the calculated hazard/risk level for 2-methylnaphthalene is less than the EPA's risk management decision range (Appendix B, Table B-3). For these reasons, the newly promulgated cleanup level for 2-methylnaphthalene does not call into question the protectiveness of the remedy.

The cleanup levels for 1,2-DCA, PCE, and TCE for FT023 groundwater, and DRO and GRO for SD024 and SD025 soil, as presented in OU4 ROD, are inconsistent with their referenced standards. The cleanup levels for 1,2-DCA, PCE, and TCE at FT023 are listed as 6 µg/L instead of the MCL standard of 5 µg/L. The cleanup levels identified for DRO and GRO at SD024 and SD025 are 1,000 and 2,000 mg/kg respectively, which is the reverse of their referenced Alaska Contaminant Matrix Level D standard. These inconsistencies appeared to be typographical errors because there is no discussion in the ROD about deviation from the referenced standards. The cleanup levels for these COCs were adjusted in a 2010 memorandum to the site file so they are consistent with the standards referenced in the ROD (USAF, 2010e).

Changes in Exposure Pathways: No changes to land use or site conditions were identified during this review period that would add or change exposure pathways identified in the risk assessment.

Changes in Toxicity and Other Contaminant Characteristics: Changes to OU4 COC chemical-specific toxicity information that occurred since the 2008 five-year review affect five of the OU4 COCs, 1,1,1-trichloroethane, 1,2-dichloroethane, cis-1,2,-dichloroethene, TCE, and PCE. The ROD-established groundwater RAOs for these COCs were assessed for protectiveness by applying the updated chemical-specific toxicity information and calculating the hazard quotients and cancer risks at the RAO concentrations. The ADEC *Risk Procedures Manual* (ADEC, 2000) was followed for the assessment. The assessment found that the groundwater RAOs for all five COCs continue to be protective of human health under a residential exposure assumption. The data used to support the risk evaluation of OU4 COC cleanup levels is included in Appendix B.

Changes in Risk Assessment Methods: None.

Expected Progress Toward Meeting RAOs: With the exception of SD025, the natural attenuation remedy is generally progressing as anticipated by the ROD. Concentrations of COCs are below RAOs at SD024 and SD028, and are generally decreasing at FT023 and SD029. Natural attenuation is occurring at FT023 and SD029, but at a rate slower than originally anticipated in the ROD. The remedy is unlikely to meet RAOs at SD025 for the foreseeable future, as monitoring data indicates an increasing trend for ethylbenzene and no statistically significant decreasing trend for benzene and toluene.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Answer: No.

7.4 OPERABLE UNIT 5

Question A: Is the remedy functioning as intended by the decision documents?

Answer: Yes.

Remedial Action Performance: The major components of the remedy at OU5 include groundwater monitoring to evaluate for natural attenuation of contaminants; construction and operation of an engineered wetland remediation system to treat contaminated seeps on the western and central bluffs; natural attenuation for the Beaver Pond wetland area; contaminated soil excavation and treatment; and LUCs. The excavation and treatment of fuel-contaminated soil was conducted from 1997 to 1999 and the construction of the wetland remediation system was completed in 1997. Ongoing components of the OU5 remedy include passive operation of the wetland remediation system to treat contaminated groundwater; groundwater, seep, surface water, and sediment monitoring to demonstrate protectiveness at the point of compliance and to evaluate the performance of natural attenuation; and LUCs. All remedial actions are operating and functioning as designed.

Contaminant concentrations in the effluent originating from the wetland remediation system and from the Beaver Pond wetland consistently meet effluent requirements. The monitoring program indicates that OU5 contaminants naturally attenuate or are contained and treated before they reach the point of compliance (Ship Creek). However, the rate that TCE naturally attenuates in some onsite wells is slower than predicted, and it is unlikely that groundwater cleanup levels will be met across the entire site by 2025, the cleanup date specified in the OU5 ROD.

Systems Operations/O&M: Since the wetland remediation system is now operating passively, O&M costs have been generally reduced. Additional reductions to O&M costs may occur as a result of monitoring well network optimization efforts.

Opportunities for Optimization: There are several optimization opportunities at OU5.

- The natural attenuation remedy is not reducing TCE concentrations in groundwater as quickly as anticipated at the time of the ROD. For this reason, a plume and source area groundwater investigation was conducted at OU5 to identify potential source areas contributing to the contamination identified in the groundwater at the site (USAF, 2011g). The *ST37 Plume and Source Area Groundwater Investigation Report* delineates potential sources areas based on historical contaminant concentrations (USAF, 2011g). If the potential sources areas could be further delineated and removed, it may be possible to significantly decrease the amount of time required to meet the established cleanup levels.
- Early warning and sentry wells are monitored to indicate if contaminants are migrating offsite toward Ship Creek. Monitoring of early warning wells was initiated to provide sufficiently early indication of contaminant migration so that contingency actions, if necessary, could be programmed and implemented prior to contaminants reaching Ship Creek. A portion of the early warning/sentry wells are located in areas that are not downgradient of any known plumes and samples collected from these wells have consistently exhibited non-detectable concentrations of COCs. Because these wells are not located downgradient of an identified plume, they do not serve their intended purpose. Optimization of the early warning and sentry monitoring well system to eliminate unnecessary wells would reduce monitoring costs.
- The *ST37 TCE Plume and Source Area Investigation Report* (USAF, 2011g), recommended that a number of monitoring wells utilized to evaluate the OU5 plumes be decommissioned and/or removed from the monitoring program based on their proximity to one another and/or their location related to the plume areas. The optimization of the monitoring well network at OU5 would reduce monitoring costs.

Early Indicators of Potential Issues: The rate that TCE naturally attenuates in some onsite wells is slower than predicted, and it is unlikely that groundwater cleanup levels will be met across the entire site by 2025, the cleanup date specified in the OU5 ROD.

A screening evaluation of the soil vapor intrusion pathway for TCE in the vicinity of the Dallas Housing area found that the indoor air pathway presented a very low to negligible risk to current and future residents (AFIOH, 2006). However, toxicity information for TCE has been updated since the 2006 vapor intrusion screening evaluation. For this reason, and because the 2006 vapor intrusion screening evaluation was not supported by any additional lines of evidence, a vapor intrusion evaluation that provides multiple lines of evidence should be conducted in accordance with EPA guidance for each occupied facility that is in proximity to the TCE plumes at OU5 to ensure the short- and long-term protectiveness of the remedy.

Vapor intrusion evaluations should be conducted prioritizing buildings with the most vulnerable populations (schools, day cares, offices, residences).

Implementation of LUCs and Other Measures: OU5 LUCs are appropriate and properly implemented. They are effective at controlling exposure pathways. Potential receptors – personnel at JBER-E – have been advised of LUC requirements through the 3 WGI 32-7003, the Base General Plan, the Work Clearance Request process, and GeoBase.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

Answer: Yes.

Changes in Standards and TBCs: Groundwater and surface water COPCs were compared to current federal and state standards. Newly promulgated cleanup levels and/or MCLs (not addressed in the ROD or previous five-year reviews) that were more stringent than those listed in the ROD or during the previous review period were identified for 2-methylnaphthalene, chloroethane, 1,1-dichloroethane, 4-methylphenol, 1,1,2,2-trichloroethane, and bromomethane (Appendix B, Table B-1). However, concentrations of the identified contaminants were below the newly established cleanup levels either at the time of the ROD or during subsequent sampling events (Table B-2); therefore, the newly promulgated cleanup levels do not call into question the protectiveness of the remedy.

Soil COPCs were also compared to current federal and state standards. New ADEC soil cleanup standards have been promulgated for 18 soil COPCs identified in the ROD, including those for various VOCs, PAHs, inorganic compounds, and petroleum hydrocarbons (Appendix B, Table B-1). However, only concentrations of chromium and silver exceeded the newly promulgated cleanup levels listed in the ROD (Table B-2). The calculated hazard/risk levels for both chromium and silver were less than the EPA risk management decision range (Table B-3); therefore, the newly promulgated cleanup levels do not call into question the protectiveness of the remedy.

Changes in Exposure Pathways: The original OU5 risk assessment did not evaluate human health risk associated with the vapor intrusion to indoor air pathway. EPA published guidance for evaluating this pathway in 2002 (EPA, 2002), after completion of the OU5 ROD. In 2006, USAF evaluated the risk of TCE vapor intrusion to indoor air for the Dallas Base Housing Area which is located over the Fairchild Avenue Plume at OU5 (AFIOH, 2006). The modeling evaluation estimated that the incremental increase in cancer risk to the base housing residents was 7.5×10^{-7} to 4.1×10^{-5}; these risks were lower than or within the EPA's risk management decision range. Toxicity information for TCE has been updated since the 2006 vapor intrusion screening evaluation. For this reason, and because the 2006 vapor intrusion screening evaluation was not supported by any additional lines of evidence, a vapor intrusion evaluation that provides multiple lines of evidence should be conducted in accordance with EPA guidance for each occupied facility that is in proximity to the TCE plumes at OU5 to ensure the short- and long-term protectiveness of the remedy

Changes in Toxicity and Other Contaminant Characteristics: Changes to OU5 COC chemical-specific toxicity information that occurred since the 2008 five-year review affect one of the OU5 COCs, TCE. The ROD-established groundwater RAO for TCE was assessed for protectiveness by applying the updated chemical-specific toxicity information and calculating the hazard quotient and cancer risk at the RAO concentration. The ADEC *Risk Procedures Manual* (ADEC, 2000) was followed for the assessment.

The assessment found that the groundwater RAO for TCE continues to be protective of human health under a residential exposure assumption. The data used to support the risk evaluation of OU5 COC cleanup levels is included in Appendix B.

Changes in Risk Assessment Methods: None.

Expected Progress toward Meeting RAOs: The natural attenuation remedy is not progressing at the rate originally expected in the ROD (cleanup by 2025). Natural attenuation appears to be occurring at a number of the wells at OU5 preventing groundwater contamination from negatively impacting the point of compliance (Ship Creek). However, the historical observation of weakly aerobic to weakly anaerobic conditions at OU5 suggests that the rate of

TCE degradation is very low. Natural attenuation of TCE is mostly likely to occur primarily as a result of dispersion, adsorption, and/or dilution. For this reason, it appears unlikely that TCE groundwater contamination at OU5 will be below cleanup levels by 2025, the cleanup date stated in the ROD.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Answer: No.

7.5 OPERABLE UNIT 6

Question A: Is the remedy functioning as intended by the decision documents?

Answer: Yes.

Remedial Action Performance: All remedial actions are operating and functioning as envisioned by the ROD and ROD updates. Groundwater at LF002 has met the cleanup goal and final sampling has been completed. Additional sampling for fuel-related compounds requested by ADEC has been recommended and is in progress. Free-product recovery at WP014 and LF004 South appears to be complete. Debris removal is conducted annually at LF004; the quantity of debris has significantly decreased over time. The Port of Anchorage expansion project has reduced the amount of debris exposed through erosion. The SD015 HVE system reached the end of its effectiveness and was shut down in 2007 and removed in 2008. The HVE system achieved cleanup levels for SD015 soil but not for groundwater. However, fuel-related compounds were detected in the soil during system decommissioning in 2008 and 2009 and a follow-up investigation was conducted in 2011. Groundwater cleanup continues at LF004 South, WP014, and SD015 through MNA. The natural attenuation process is generally working as intended, though somewhat slower or more variably than originally expected in a few of the wells and seeps.

Systems Operations/O&M: Operating procedures, as implemented, maintain the effectiveness of the remedial actions. With the exception of 2012, O&M costs for OU6 have decreased substantially in the past five years. Overall costs have decreased due to the shutdown of the

HVE system, close-out of LF002 monitoring, and reductions in LF004 erosional debris. There are no indications of problems that could place protectiveness at risk.

Early Indicators of Potential Issues: The natural attenuation process is progressing at a slower rate than anticipated for groundwater at LF004 South, WP014, and the perched aquifer at SD015. Groundwater at LF004 South and WP014 was expected to meet RAOs by 2017 and the perched aquifer at SD015 was expected to meet RAOs by 2015. Monitoring results indicate that these timeframes will not be met.

Opportunities for Optimization: When the final TAH and TAqH samples confirm that LF002 surface water has reached cleanup goals and the LF002 seep has been determined to meet closure requirements, a memorandum to the site file that documents that groundwater and surface water meet cleanup levels can be prepared that recommends a status of “Response Complete” for this site.

Implementation of LUCs and Other Measures: OU6 LUCs are appropriate and properly implemented. They are effective at preventing exposure and are expected to remain effective in the future. Contaminant levels at LF002, LF003, LF004, WP014, and SD015 that exceed cleanup goals based on a UU/UE scenario are within the LUC boundary. Potential receptors – personnel at JBER-E – have been advised of LUC requirements through the 3 WGI 32-7003, the Base General Plan, the Work Clearance Request process, and GeoBase. Access controls are in place at LF004. The extensive quarry operations for fill material conducted at Cherry Hill borrow pit to support the Port of Anchorage expansion avoided all OU6 sites, which indicates that LUCs were successfully implemented. Quarry operations were designed to avoid contact with groundwater by including a 5-foot buffer between the bottom of the excavation and the groundwater table. There was no standing water in any of the excavations, indicating that excavations stopped short of the water table. The Port of Anchorage expansion is west of LF004 and Port employees will not be working within the LF004 boundary, so no additional LUCs are required.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

Answer: Yes.

Changes in Standards and TBCs: Although the OU6 RI/FS identified COPCs, none were specified in the OU6 ROD. Instead, the OU6 ROD listed all contaminants detected and the COCs for each site. Groundwater, surface water, and soil contaminant detections as listed in the ROD were compared to current federal and state standards.

Groundwater COPCs were compared to the current federal and state standards. New ADEC cleanup standards and/or MCLs (not addressed in the ROD or previous five-year reviews) that were more stringent than at the time of the ROD or during the previous review period have been promulgated for 15 COPCs.

However, only concentrations of 2-methylnaphthalene and arsenic exceeded the newly promulgated cleanup levels at the time of the ROD (Appendix B, Table B-2). Of the two analytes, only 2-methylnaphthalene had the potential to result in a hazard/risk level greater than the EPA risk management decision range (Table B-3). Both of the contaminants that exceeded their newly established cleanup levels are discussed below:

- Arsenic exhibited a maximum concentration at 74.8 µg/L at the time of the ROD, well above the newly promulgated cleanup level of 10 ug/L. However, arsenic was not originally considered a COC at the time of the ROD because concentrations detected at LF004 were indicative of background levels at the site. For these reasons, the new soil cleanup standard does not call into question the protectiveness of the remedy.
- A concentration of 2-methylnaphthalene was detected at 630 µg/L during sampling activities at WP014, at the time of the ROD. As stated above, the calculated hazard risk associated with this concentration exceeds the EPA risk management decision range. Based on the potential risk associated with the maximum concentration of 2-methylnaphthalene detected in the groundwater at WP014 during the time of the ROD, sampling for this analyte should occur to determine the current concentration present at the site.

Surface water COPCs were also compared to the current cleanup levels listed in the ROD. New ADEC cleanup standards and/or MCLs (not addressed in the ROD or previous five-year reviews) have been promulgated for arsenic and phenol. Concentrations of the aforementioned contaminants were below the newly established cleanup levels at the time ROD. Therefore, the newly promulgated cleanup levels do not call into question the protectiveness of the remedy.

Soil COPCs were compared to the current cleanup levels listed in the ROD. New ADEC soil cleanup standards (not addressed in the ROD or previous five-year reviews) that were more stringent than at the time of the ROD or during the previous review period have been promulgated for 39 soil COPCs identified in the ROD (Appendix-B, Table B-1). However, only benzene, 1,2-dichlorobenzene, 1,4-dichlorobenzene, bis(2-ethylhexyl)phthalate, PCE, and thallium exceeded the newly promulgated cleanup levels at the time of the ROD (Table B-2). Only the calculated hazard/risk level for thallium was greater than the EPA risk management decision range (Table B-3); therefore, the newly promulgated cleanup levels for benzene, 1,2-dichlorobenzene, 1,4-dichlorobenzene, bis(2-ethylhexyl)phthalate, and PCE do not call into question the protectiveness of the remedy.

A concentration of thallium which exceeds the current cleanup level (1.9 mg/kg) was detected at 12 mg/kg in one location at LF002 at the time of the ROD. As stated above the calculated direct contact hazard level for thallium was greater than the EPA risk management decision range (Appendix B, Table B-3). The surface sample location was covered as part of the remedial action for lead removing the potential for direct contact. Thallium was a COPC in groundwater as a result of the potential to migrate to groundwater. As of 2009, the concentrations in groundwater have been confirmed to be below cleanup levels. Therefore, the newly promulgated cleanup level does not call into question the protectiveness of the remedy.

<u>Changes in Exposure Pathways</u>: The only change to the land use or site conditions identified during this review period that would change exposure pathways identified in the risk assessment is the reduction in public access to the soil and area below the bluff at LF004. The Port of Anchorage expansion project has limited recreational access to the area west of LF004 and reduced the area available for ecological receptors by covering portions of the sediment where debris and soil fell from the bluff.

Changes in Toxicity and Other Contaminant Characteristics: Changes to OU6 COC chemical-specific toxicity information that occurred since the 2008 five-year review affect four of the COCs, 1,1,2,2-PCA, 1,2-dichloroethane, methylene chloride and TCE. The ROD-established groundwater RAOs for these COCs were assessed for protectiveness by applying the updated chemical-specific toxicity information and calculating the hazard quotient and cancer risk at the RAO concentration. The ADEC *Risk Procedures Manual* (ADEC, 2000) was followed for the assessment.

The assessment found that the groundwater RAOs continue to be protective of human health under a residential exposure assumption. The data used to support the risk evaluation of OU6 COC cleanup levels is included in Appendix B.

Changes in Risk Assessment Methods: None.

Expected Progress toward Meeting RAOs: The remedies at OU6 are generally progressing as intended, though at a slower rate than anticipated at the time of the ROD for a few COCs. Chlorinated solvents at LF004 have met the RAOs. Benzene concentrations at few groundwater sampling locations at LF004 South and WP014 along with ethylbenzene at OU6MW-46 will take longer than expected to reach cleanup goals; current data indicate no decreasing trends, and reliable cleanup dates cannot be predicted for any of these sites at this time. LF004 and WP014 MNA data also indicate degradation is still occurring in some wells that have met cleanup levels for COCs, indicating that DRO or GRO may also be present. At SD015, the HVE/SVE system succeeded in meeting soil cleanup levels but not groundwater. TCE results are decreasing in one well. Benzene concentrations do not indicate a decreasing trend. A cleanup date cannot be predicted for SD015.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Answer: No.

7.6 DP098

Question A: Is the remedy functioning as intended by the decision documents?

Answer: Yes.

Remedial Action Performance: The remedy at DP098 has been implemented and continues to operate and function as designed. Although TCE is detected in surface water collected near 41755WL-08, contaminant concentrations at the ROD-specified point of compliance consistently meet requirements.

In general, the monitoring program data indicates that DP098 contaminants are naturally attenuating. However, the rate at which the COCs are naturally attenuating at each well is variable. Groundwater data were compiled to assist in the evaluation of the MNA remedy. The COC plume appears to be stable and is not likely to expand beyond the LUC boundary. All components of the ROD-specified remedy have been implemented.

Systems Operations/O&M: With the exception of 2012, annual O&M costs for DP098 have generally decreased since 2008; however, if the enhanced bioremediation is extended beyond pilot testing, costs are likely to escalate. Operating procedures, as implemented, are expected to maintain the effectiveness of the response actions.

Opportunities for Optimization: Evaluate the applicability of increasing the scale of the pilot tests to improve remedial performance.

Implementation of LUCs and Other Measures: DP098 LUCs are appropriate and properly implemented. They are effective at controlling exposure pathways. Potential receptors – personnel at JBER-E – have been advised of LUC requirements through the 3 WGI 32-7003, the Base General Plan, the Work Clearance Request process, and GeoBase.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

Answer: Yes.

Changes in Standards and TBCs: The DP098 ROD (USAF, 2004a) identified two ARARs, the National Primary Drinking Water Regulations 40 CFR §141.61 and ADEC *Oil and Other Hazardous Substances Pollution Control* 18 AAC 75. Although not identified as an ROD ARAR, surface water standards found in ADEC Water Quality Standards (18 AAC 70) is a TBC as surface water is present in the DP098 LUC area. Maximum drinking water contaminant levels defined in 40 §141.61 Subpart G have not been updated during the review period. Both 18 AAC 75 and 18 AAC 70 were updated on April 8, 2012.

Analytes retained as groundwater, sediment, soil, or surface water COPCs in the ROD were compared to current cleanup levels. A new ADEC cleanup standard and/or MCLs (not addressed in the ROD or previous five-year reviews) had been promulgated for one groundwater COPC (chloromethane) (Appendix B, Table B-1). However, the maximum concentration of chloromethane detected at the site at the time of the ROD was below the newly promulgated cleanup level; therefore, the newly promulgated cleanup level does not call into question the protectiveness of the remedy (Table B-2).

The ROD noted that TCE was not selected as a COC for surface waters because the cumulative cancer risk and hazard index were below EPA and ADEC target health goals using the risk assessment exposure scenario.

Changes in Exposure Pathways: As described in Section 7.0, the assessment of potential vapor intrusion risk to indoor air has evolved significantly during the review period; requiring multiple lines of evidence to support assessment findings. A manned facility is located in close proximity to the DP098 groundwater plume. Historic vapor intrusion assessments have occurred at DP098; however, additional lines of evidence are needed to support short- and long-term protectiveness.

Changes in Toxicity and Other Contaminant Characteristics: Changes to DP098 COC chemical-specific toxicity information that occurred since the 2008 five-year review affect three of the COCs, cis-1,2-DCE, TCE, and PCE. The ROD-established groundwater RAOs were assessed for protectiveness by applying the updated chemical-specific toxicity information and calculating the hazard quotient and cancer risk at the RAO concentration.

The ADEC *Risk Procedures Manual* (ADEC, 2000) was followed for the assessment. The assessment found that the groundwater RAOs continue to be protective of human health under a residential exposure assumption. The data used to support the risk evaluation of DP098 COC cleanup levels is included in Table B-1 of Appendix B

The vapor intrusion pathway was considered in the risk assessment that supported the DP098 ROD. However, results from the vapor intrusion sampling were not available at the time of this review. TCE vapor intrusion risk at DP098 should be re-evaluated using the current toxicity information, which has been updated since 2008.

<u>Changes in Risk Assessment Methods:</u> None.

<u>Expected Progress toward Meeting RAOs:</u> The MNA remedy is progressing slowly, particularly the attenuation of vinyl chloride. An accurate cleanup date for the site cannot be reasonably predicted at this time. However, it does not appear that the 35- to 75-year remedy timeframe identified in the ROD will be achieved.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Answer: No.

7.7 TECHNICAL ASSESSMENT SUMMARY

Past and current data from system monitoring indicate that the remedies are generally performing as intended by the decision documents for OUs 1, 2, 4, 5, and 6 and DP098. Groundwater cleanup levels appear to have been met at SD024 and SD028 in OU4 and LF002 in OU6. If two consecutive rounds of sampling at SD024, SD028, and LF002 indicate groundwater is below cleanup levels identified in the ROD, the USAF will request a status of “Response Complete” for groundwater. The groundwater at LF059 should be proposed for NFA, as the groundwater at LF059 affected by the upgradient source. Shallow and deep soils meet cleanup levels at all OU4 sites. Based on monitoring data, the natural attenuation remedy at most sites is occurring slower than originally intended, particularly at OU5. For this reason, the timeframes established in the RODs for cleanup of groundwater at OU2, OU4, OU5, OU6, and DP098 may not be achievable based on current natural attenuation rates.

O&M procedures, as implemented, are expected to maintain the effectiveness of response actions. As a whole, the JBER-E remediation program has been highly optimized, but remaining optimization opportunities are possible at the wetland remediation system and monitoring program at OU5. LUCs are in place and are preventing exposure for all JBER-E OUs and sites.

A review of changes in exposure assumptions, toxicity data, and cleanup levels since the time of the remedy selection has not revealed any issues that affect remedy protectiveness at OU1, OU2, and OU6. All of the cleanup levels for the final COCs are still protective according to the current regulatory cleanup levels and associated risk evaluations. As described in Section 7.0, the assessment of potential vapor intrusion risk to indoor air has evolved significantly during the review period; requiring multiple lines of evidence to support assessment findings. Therefore, the protectiveness of the selected remedies at OU4, OU5, and DP098 cannot be determined until the vapor intrusion pathways have been properly evaluated in accordance with EPA guidance.

There have been no changes to the physical conditions of the sites that could affect the protectiveness of the remedies. Development on or near sites, including the Port of Anchorage expansion below LF004, has been conducted in close coordination with JBER-E Environmental Restoration Personnel to eliminate the possibility of exposure and to ensure that remedial actions continue unimpeded and LUCs remain effective.

8.0 ISSUES

This section details issues related to current site operations, conditions, or activities and evaluates whether the issues affect current or future protectiveness of the associated remedy. The issues identified during this Five-Year Review that affect protectiveness are presented in Table 8-1. The issues identified during this Five-Year Review that do not affect protectiveness are presented in Table 8-2. Recommendations and follow-up actions concerning issues identified in Tables 8-1 and 8-2 are presented in Tables 9-1 and 9-2, respectively.

Table 8-1
Issues Identified During the Five-Year Review (2014) that Affect Protectiveness

Issue No.	OU	Site	Issue	Affects Current Protectiveness?	Affects Future Protectiveness?
1	OU1	LF059	An upgradient source of trichloroethene (TCE) and 1,1,2,2-tetrachloroethane is contaminating groundwater in the northwest portion of the Site LF059 LUC area. Although TCE concentrations at affected wells are relatively low, TCE shows no decreasing trends. The 1994 OU1 ROD predicted that contaminant levels in groundwater would meet acceptable human risk levels and Safe Drinking Water standards within five years of implementing the monitoring program (by 1999).	No	Yes
2	OU2	ST041	Although COCs in the groundwater at ST041 are showing decreasing trends, RAOs will not be met within the 21-year timeframe specified in the ROD (by 2016). Additionally, the ROD identifies a “contingent remedy” that will be implemented if USAF, in consultation with ADEC and EPA, determine that natural attenuation is not occurring at an acceptable rate.	No	Yes

Table 8-1
Issues Identified During the Five-Year Review that Affect Protectiveness (Continued)

Issue No.	OU	Site	Issue	Affects Current Protectiveness?	Affects Future Protectiveness?
3	OU4	SD025	The 1995 OU4 ROD established 2008 as the groundwater cleanup date (a 13-year timeframe); however, concentrations of benzene at SD025 remain at least an order of magnitude above cleanup levels. No decreasing trends for two of the COCs (toluene and benzene) could be established and an increasing trend was identified for ethylbenzene. Therefore, a cleanup date cannot be predicted at this time.	No	Yes
4	OU4	FT023, SD025, and SD029	Manned facilities are present in the vicinity of the contaminant plumes associated with the OU4 active sites FT023, SD025, and SD029, indicating a potential for vapor intrusion to occur at those facilities.	No	Yes
5	OU5	ST037	Based on the large historical release of fuel identified in the RI report, the potential exists for significant residual fuel contamination to remain in the soil that may act as a source of groundwater contamination. The extent of the soil source area affecting groundwater and thereby contributing to the benzene and petroleum hydrocarbon contamination detected in seeps OU5SP-01 and OU5SP-02 is not well delineated.	No	Yes
6	OU5	ST037	The 2006 vapor intrusion screening evaluation performed for TCE in the vicinity of the Fairchild Avenue Plume and the Dallas base housing area utilized toxicity information that has since been updated. Additionally, no supplemental testing has been conducted to support the findings of the screening evaluation.	No	Yes

Table 8-1
Issues Identified During the Five-Year Review that Affect Protectiveness (Continued)

Issue No.	OU	Site	Issue	Affects Current Protectiveness?	Affects Future Protectiveness?
7	OU5	ST037	Groundwater monitoring results at OU5 indicate that natural attenuation remedies are generally decreasing COC concentrations. However, the process is slower than anticipated in the 1995 ROD, and it is unlikely that concentrations of COCs will fall below their respective cleanup levels prior to the ROD-specified cleanup date (2025).	No	Yes
8	OU6	LF004 South, WP014, and SD015	Review of historical data indicate no decreasing trend and an increasing trend for some COCs in the groundwater at LF004 South, WP014 (OU6MW-46), and SD015. It is not possible to predict a reliable cleanup date for these OU6 sites.	No	Yes
9	OU6	WP014	Based on the maximum concentration of 2-methylnaphthalene identified in the groundwater at WP014 during the time of the ROD (630 µg/L) the calculated risk exceeds the hazard quotient threshold for non-cancer chemicals.	No	Yes
10	N/A	DP098	Indoor air sampling at DP098 appears to indicate that no unacceptable risk is occurring. However, the historical efforts do not meet the current standard of multiple lines of evidence.	No	Yes

Note:
For definitions, see the Acronyms and Abbreviations section.

Table 8-2
Issues Identified During the Five-Year Review (2014) that Do Not Affect Protectiveness

Issue No.	OU	Site	Issue	Affects Current Protectiveness?	Affects Future Protectiveness?
11	OU1	LF059	The potential exists for concentrations of 1,4-dioxane to be present in conjunction with TCE contamination at the site.	No	No
12	OU2	ST041	Monitoring well ST41-25 showed signs of frost heaving during site inspection activities.	No	No
13	OU2	ST041	Monitoring well ST41-10R is not being sampled in accordance with the decision guide for monitoring well sampling frequency at OU2 provided in the 2011 *Memorandum to the Site File: Operable Unit 2*.	No	No
14	OU4	FT023 and SD029	The potential exists for concentrations of 1,4-dioxane to be present in conjunction with TCE contamination at the site.	No	No
15	OU4	FT023	Monitoring well GW-5A has not been sampled since 2009, making it difficult to determine plume progression at the FT023 South Plume.	No	No
16	OU4	SD028	Contaminants in the groundwater at SD028 are below cleanup levels.	No	No
17	OU4	SD024	Contaminants in the groundwater at SD024 are below cleanup levels.	No	No
18	OU5	ST037	The potential exists for concentrations of 1,4-dioxane to be present in conjunction with TCE contamination at the site.	No	No
19	OU5	ST037	Several monitoring wells that comprise the early warning and sentry monitoring well network are not located downgradient of plumes.	No	No

Table 8-2
Issues Identified During the Five-Year Review (2014) that Do Not Affect Protectiveness (Continued)

Issue No.	OU	Site	Issue	Affects Current Protectiveness?	Affects Future Protectiveness?
20	OU5	ST037	The monitoring well network at OU5 needs to be properly optimized to ensure that appropriate delineation of plume boundaries is occurring.	No	No
21	OU5	ST037	Several seeps were identified as not being properly labeled and demarcated.	No	No
22	OU6	LF004 and SD015	The potential exists for concentrations of 1,4-dioxane to be present in conjunction with TCE contamination at the site.	No	No
23	OU6	LF002	Contaminants in the groundwater at LF002 are below cleanup levels.	No	No
24	OU6	LF004	Continue with the plan to sample LF004 seeps for TAH and TAqH to assess whether these seeps are meeting surface water quality standards. If the seeps do not meet water quality standards, fuel-related compounds DRO and GRO in upgradient wells need to be analyzed to predict when and if the LF004 seeps will meet surface water quality standards.	No	No
25	OU6	SD015	No downgradient monitoring well exists at SD015.	No	No
26	N/A	DP098	The potential exists for concentrations of 1,4-dioxane to be present in conjunction with TCE contamination at the site.	No	No
27	N/A	DP098	Groundwater COC data indicates variable conditions favorable to reductive dechlorination at DP098.	No	No

Table 8-2
Issues Identified During the Five-Year Review (2014) that Do Not Affect Protectiveness (Continued)

Issue No.	OU	Site	Issue	Affects Current Protectiveness?	Affects Future Protectiveness?
28	OUs 1, 2, 3, 4, 5, 6 and DP098	All Sites	The LF004 CERCLA site boundary appears to extend beyond JBER-E site boundaries.	No	No
29	OUs 1, 2, 3, 4, 5, 6 and DP098	All Sites	An in-depth description of the historical site events for each OU and DP098 was not included within Table 2-1 of this five-year review.	No	No

9.0 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Recommendations and follow-up actions that affect protectiveness have been identified, as shown in Table 9-1, to address the issues presented in Table 8-1. Recommendations and follow-up actions for issues have been identified, as shown in Table 9-2, to address the issues presented in Table 8-2. The USAF will prepare separate closure documents for those sites that are targeted for closure.

Table 9-1
Recommendation and Follow-up Actions for Issues Identified in the Five-Year Review (2014) that Affect Protectiveness

Issue No.	OU	Site	Recommendations/ Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Follow-up Actions: Affects Current Protectiveness?	Follow-up Actions: Affects Future Protectiveness?
1	OU1	LF059	Pursue a "Response Complete" status for LF059. Delineate the upgradient plume affecting LF059 that likely originates at closed site LF007. Pursue reopening LF007 under the CERCLA program and manage the groundwater plume that is affecting part of LF059 as part of the upgradient source.	USAF	EPA/ADEC	12/31/2016	No	Yes
2	OU2	ST041	Determine the rate of natural attenuation at OU2. Evaluate whether the contingency remedy should be implemented.	USAF	EPA/ADEC	12/31/2016	No	Yes
3	OU4	SD025	Evaluate alternative remedial strategies to accelerate attainment of cleanup levels in groundwater at SD025.	USAF	EPA/ADEC	12/31/2016	No	Yes
4	OU4	FT023, SD025, and SD029	A vapor intrusion evaluation that provides multiple lines of evidence should be conducted in accordance with EPA guidance for each occupied facility that is in proximity to the VOC plume(s) at FT023, SD025, and SD029. Vapor intrusion evaluations should be conducted prioritizing buildings with the most vulnerable populations (schools, day cares, offices, residences).	USAF	EPA/ADEC	12/31/2016	No	Yes
5	OU5	ST037	Identify the extent of soil contamination that is resulting in elevated concentrations of benzene and petroleum products identified in seeps OU5SP-01 and OU5SP-02. An assessment of residual soil contamination will be needed to predict the timeframe to meet RAOs at seeps OU5SP-01 and OU5SP-02.	USAF	EPA/ADEC	12/31/2017	No	Yes
6	OU5	ST037	A vapor intrusion evaluation that provides multiple lines of evidence should be conducted in accordance with EPA guidance for each occupied facility that is in proximity to the TCE plumes at OU5. Vapor intrusion evaluations should be conducted prioritizing buildings with the most vulnerable populations (schools, day cares, offices, residences).	USAF	EPA/ADEC	12/31/2016	No	Yes
7	OU5	ST037	Utilize the findings from the *ST37 Plume and Source Area Groundwater Investigation Report* and continue to delineate the plume boundaries and potential source areas at OU5. Evaluate alternative remedial strategies to accelerate attainment of cleanup levels in groundwater.	USAF	EPA/ADEC	12/31/2017	No	Yes

Table 9-1
Recommendation and Follow-up Actions for Issues Identified in the Five-Year Review (2014) that Affect Protectiveness (Continued)

Issue No.	OU	Site	Recommendations/ Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Follow-up Actions: Affects Current Protectiveness?	Follow-up Actions: Affects Future Protectiveness?
8	OU6	LF004 South, WP014, and SD015	Perform remedial process optimization for LF004 South, WP014, and SD015 since it does not appear that there will be sufficient progress in the timeframe established in the ROD.	USAF	EPA/ADEC	12/31/2016	No	Yes
9	OU6	WP014	Based on the potential risk associated with the maximum concentration of 2-methylnaphthalene detected in the groundwater at WP014 during the time of the ROD, the analyte should be re-sampled for to determine the concentration present at the site and to determine if current concentrations present an unacceptable risk.	USAF	EPA/ADEC	12/31/2016	No	Yes
10	N/A	DP098	A vapor intrusion evaluation that provides multiple lines of evidence should be conducted in accordance with EPA guidance for each occupied facility that is in proximity to the TCE plumes at DP098. Vapor intrusion evaluations should be conducted prioritizing buildings with the most vulnerable populations (schools, day cares, offices, residences).	USAF	EPA/ADEC	12/31/2016	No	Yes

Note:
For definitions, see the Acronyms and Abbreviations section.

Table 9-2
Recommendation and Follow-up Actions for Issues identified in the Five-Year Review (2014) that Do Not Affect Protectiveness

Issue No.	OU	Site	Recommendations/ Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Follow-up Actions: Affects Current Protectiveness?	Follow-up Actions: Affects Future Protectiveness?
11	OU1	LF059	Based on USAF guidance (*Interim Air Force Guidance on Sampling and Response Actions for 1,4-Dioxane at Operational and BRAC Installations, 15 Aug 2013*), recommend a sampling event be conducted to identify if concentrations of 1,4-dioxane exist. Determine whether there is an unacceptable risk at the site.	USAF	EPA/ADEC	2016	No	No
12	OU2	ST041	Perform maintenance on monitoring well ST41-25, which showed signs of frost heaving during site inspection activities.	USAF	EPA/ADEC	2014	No	No
13	OU2	ST041	Reevaluate the sampling frequency for monitoring well ST41-10R based on the decision guide for monitoring well sampling frequency at OU2 provided in the 2011 *Memorandum to the Site File: Operable Unit 2*.	USAF	EPA/ADEC	2015	No	No
14	OU4	FT023 and SD029	Based on USAF guidance (*Interim Air Force Guidance on Sampling and Response Actions for 1,4-Dioxane at Operational and BRAC Installations, 15 Aug 2013*), recommend a sampling event be conducted to identify if concentrations of 1,4-dioxane exist. Determine whether there is an unacceptable risk at the sites.	USAF	EPA/ADEC	2016	No	No
15	OU4	FT023	Monitoring well GW-5A has not been sampled since 2009. Because COCs in monitoring well OU4W-11 are approaching the cleanup levels, it is recommended that GW-5A be sampled again to gain understanding of how the rest of the plume is progressing.	USAF	EPA/ADEC	2014	No	No
16	OU4	SD028	Conduct two rounds of groundwater sampling. If two consecutive rounds of sampling indicate groundwater is below cleanup levels identified in the ROD, the USAF will request no further remedial action for groundwater.	USAF	EPA/ADEC	2014	No	No
17	OU4	SD024	Prepare a memorandum to the site file documenting that groundwater meets cleanup levels at SD024 and recommend a Cleanup Complete determination for this site.	USAF	EPA/ADEC	2014	No	No
18	OU5	ST037	Based on USAF guidance (*Interim Air Force Guidance on Sampling and Response Actions for 1,4-Dioxane at Operational and BRAC Installations, 15 Aug 2013*), recommend a sampling event be conducted to identify if concentrations of 1,4-dioxane exist. Determine whether there is an unacceptable risk at the site.	USAF	EPA/ADEC	2016	No	No
19	OU5	ST037	Optimize early warning and sentry monitoring well network to eliminate wells that are not downgradient of plumes and consider additional wells where there is a greater probability of contaminant migration.	USAF	EPA/ADEC	2017	No	No
20	OU5	ST037	Optimize the groundwater monitoring network at OU5 as recommended in the *ST37 TCE Plume and Source Area Investigation Report* (USAF, 2011g).	USAF	EPA/ADEC	2017	No	No
21	OU5	ST037	Ensure that the seeps at OU5 are properly labeled and demarcated to ensure that they are sampled appropriately in the future.	USAF	EPA/ADEC	2014	No	No

Table 9-2
Recommendation and Follow-up Actions for Issues Identified in the Five-Year Review (2014) that Do Not Affect Protectiveness (Continued)

Issue No.	OU	Site	Recommendations/ Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Follow-up Actions: Affects Current Protectiveness?	Follow-up Actions: Affects Future Protectiveness?
22	OU6	LF004 and SD015	Based on USAF guidance (*Interim Air Force Guidance on Sampling and Response Actions for 1,4-Dioxane at Operational and BRAC Installations, 15 Aug 2013*), recommend a sampling event be conducted to identify if concentrations of 1,4-dioxane exist. Determine whether there is an unacceptable risk at the sites.	USAF	EPA/ADEC	2016	No	No
23	OU6	LF002	Continue with the plan to sample the LF002 seep for TAH and TAqH to assess whether this seep meets surface water quality standards. Once the LF002 seep has been determined to meet these closure requirements, prepare a memorandum to the site file documenting that groundwater and surface water meet cleanup levels and recommend a status of "Response Complete" for this site.	USAF	EPA/ADEC	2015	No	No
24	OU6	LF004	Continue with the plan to sample LF004 seeps for TAH and TAqH to assess whether these seeps are meeting surface water quality standards. If the seeps do not meet water quality standards, fuel-related compounds DRO and GRO in upgradient wells need to be analyzed to predict when and if the LF004 seeps will meet surface water quality standards.	USAF	EPA/ADEC	2015	No	No
25	OU6	SD015	Install a downgradient monitoring well at SD015 to properly delineate the site's plume boundaries.	USAF	EPA/ADEC	2016	No	No
26	N/A	DP098	Based on USAF guidance (*Interim Air Force Guidance on Sampling and Response Actions for 1,4-Dioxane at Operational and BRAC Installations, 15 Aug 2013*), recommend a sampling event be conducted to identify if concentrations of 1,4-dioxane exist. Determine whether there is an unacceptable risk at the site.	USAF	EPA/ADEC	2016	No	No
27	N/A	DP098	Conduct sampling at DP098 for MNA parameters [nitrate/nitrite, manganese (II), iron (II), sulfate, and methane] prior to the next five-year review to identify where variably favorable conditions that support reductive dechlorination are present. Although the timeframe to meet RAOs (35 to 75 years) at DP098 are decades away, a more detailed understanding of aquifer conditions will be needed for future remedy evaluations.	USAF	EPA/ADEC	2018	No	No
28	OUs 1, 2, 3, 4, 5, 6 and DP098	All Sites	All CERCLA site boundaries should be reviewed for accuracy and be revised, when applicable, in a memorandum to the site file.	USAF	EPA/ADEC	2015	No	No
29	OUs 1, 2, 3, 4, 5, 6 and DP098	All Sites	Expand Table 2-1 in the next five-year review to include detailed information concerning the chronology of site events for each OU and DP098.	USAF	EPA/ADEC	2018	No	No

Note:
For definitions, see the Acronyms and Abbreviations section.

10.0 PROTECTIVENESS STATEMENTS

Protectiveness statements for each OU at which a remedial action has been initiated were developed in accordance with EPA *Five-Year Review Guidance* (EPA, 2001) and are included in this section.

10.1 OPERABLE UNIT 1

The remedy at OU1 is currently protective of human health and the environment because LUCs restrict access to the subsurface. However, in order for the remedy to be protective in the long-term, the upgradient plume affecting LF059, likely originating at closed site LF007, will need to be fully delineated.

10.2 OPERABLE UNIT 2

The remedy at ST041 is currently protective of human health and the environment because LUCs are preventing exposure to contaminated groundwater and soil. However, in order for the remedy to be protective in the long-term, the remedial processes selected in the ROD will need to be optimized or the contingency remedy will need to be selected and implemented because it does not appear that there will be sufficient progress in the timeframe established in the ROD.

10.3 OPERABLE UNIT 4

Protectiveness determination of the remedy at OU4 is deferred until the potential impacts associated with the vapor intrusion pathway at the site are evaluated. The vapor intrusion assessment is expected to be performed in 2016. Vapor intrusion evaluations will be conducted prioritizing buildings with the most vulnerable populations (schools, day cares, offices, residences).

10.4 OPERABLE UNIT 5

Protectiveness determination of the remedy at OU5 is deferred until the potential impacts associated with the vapor intrusion pathway at the site are evaluated. The vapor intrusion assessment is expected to be performed in 2016. Vapor intrusion evaluations will be conducted prioritizing buildings with the most vulnerable populations (schools, day cares, offices, residences).

Delineation of the OU5 TCE source areas and plume boundaries is needed to ensure long-term protectiveness.

10.5 OPERABLE UNIT 6

The remedies at OU6 currently protect human health and the environment because LUCs are preventing exposure to contaminated groundwater and soil. However, in order for the remedy to be protective in the long-term, the remedial action selected in the ROD will need to be optimized because it does not appear that there will be sufficient progress in meeting groundwater cleanup levels in the timeframe established in the ROD.

LF002 meets the ROD-specified cleanup levels; therefore, a “Response Complete” determination with continued implementation of LUCs is recommended for the site.

10.6 DP098

Protectiveness determination of the remedy at DP098 is deferred until the potential impacts associated with the vapor intrusion pathway at the site are evaluated. The vapor intrusion assessment is expected to be performed in 2016. Vapor intrusion evaluations will be conducted prioritizing buildings with the most vulnerable populations (schools, day cares, offices, residences).

11.0 NEXT REVIEW

Future five-year reviews for OUs 1, 2, 4, 5 and 6 and DP098 are necessary because contamination remains above levels that allow for UU/UE in these areas. The next five-year review is due on or before March 17, 2019.

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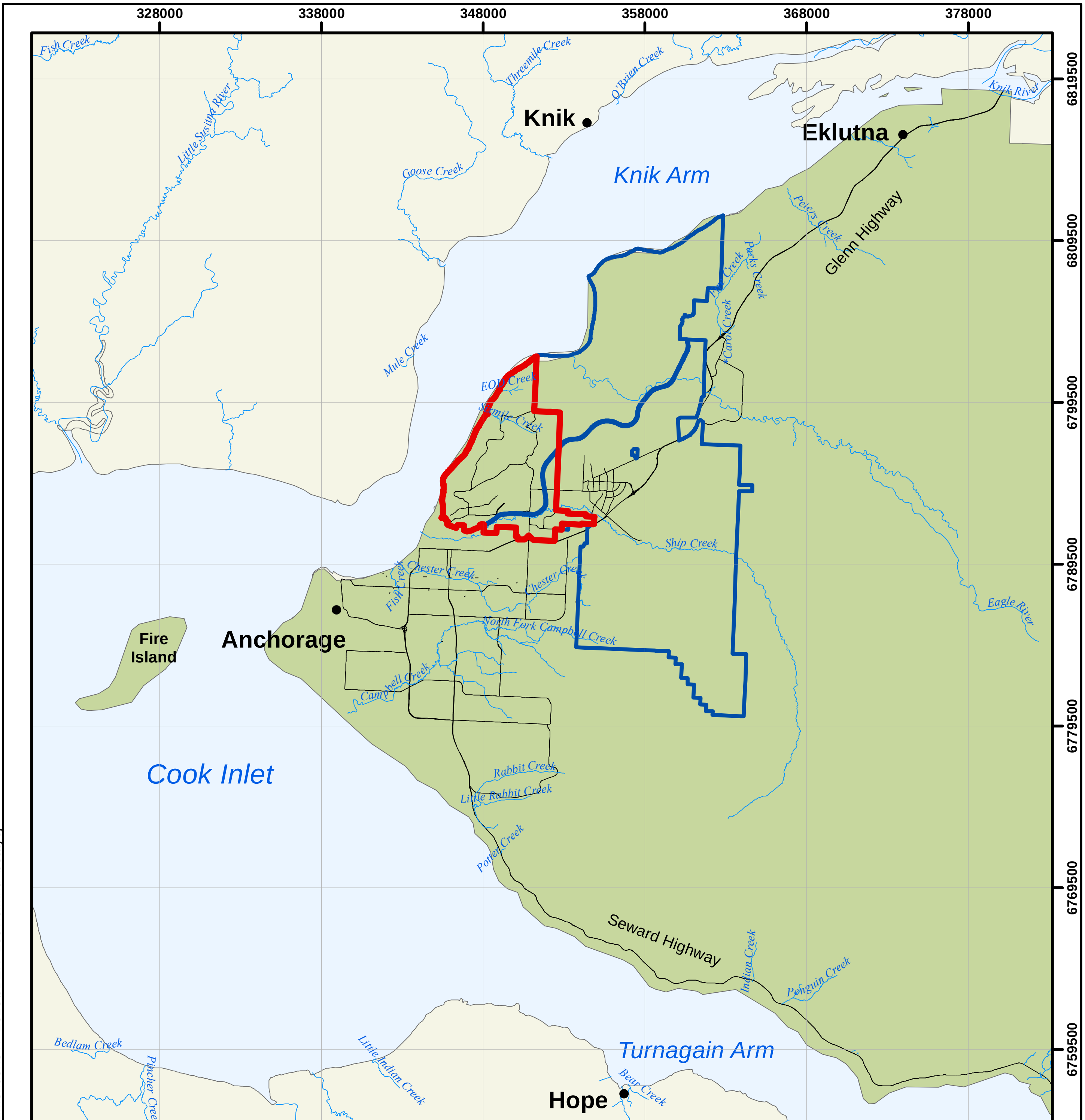
APPENDIX A

Location Maps



- Town
- Hydrography
- Major Road
- Legacy Elmendorf Boundary
- JBER Boundary
- Municipality of Anchorage

0 2.5 5 7.5 10
Miles

WGS 1984 UTM Zone 6N Meter

N

JBER-ELMENDORF LOCATION MAP

JOINT BASE ELMENDORF-RICHARDSON, ALASKA

	DATE:	PROJECT MANAGER:	FIGURE NO:
JACOBS	25 FEB 2014	K. MAHER	A-1

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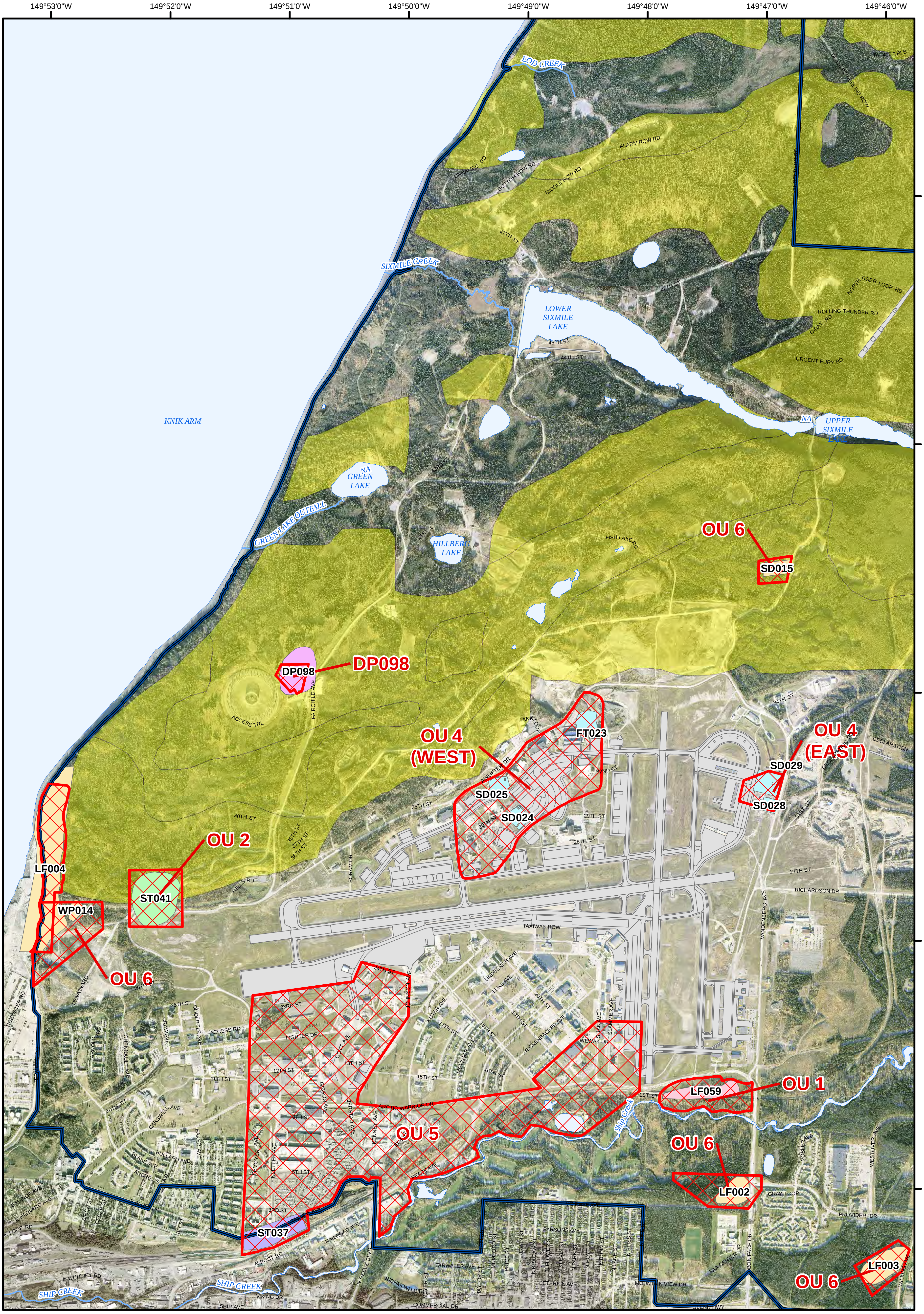

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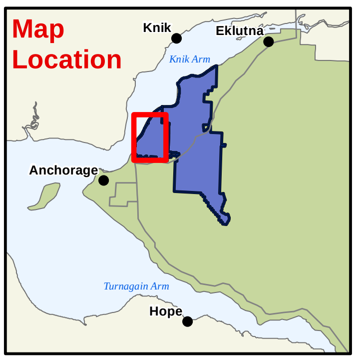


- OU 1
- OU 2
- OU 4
- OU 5
- OU 6
- DP098
- LUC Boundary
- Hydrography
- Airfield
- JBER-Elmendorf Boundary
- Elmendorf Moraine

All Locations Are Approximate

0 0.25 0.5 0.75 1

Miles

WGS 1984 UTM Zone 6N

N

JBER - ELMENDORF
2013 FIVE-YEAR REVIEW CERCLA SITES AND LUC BOUNDARIES

JOINT BASE ELMENDORF-RICHARDSON, ALASKA

	DATE:	PROJECT MANAGER:	FIGURE NO:
JACOBS	05 MAR 2014	K. MAHER	A-2

P:\JBER\AFCEE-08\TO142_FiveYearReview\MXD\Elmendorf5Yr_2013\LUC_BoundariesAtActiveCERCLA_Sites.mxd beatycj

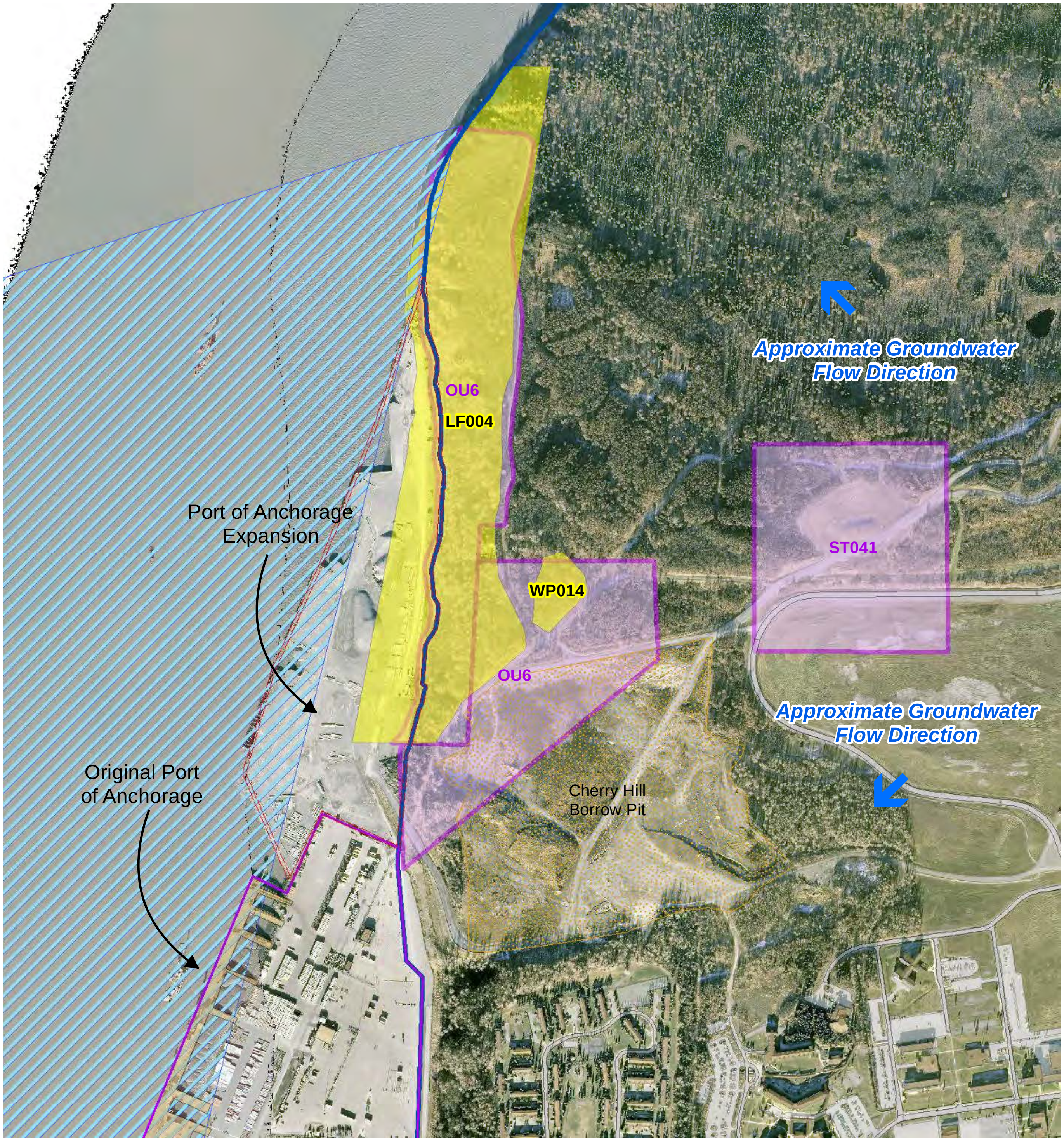
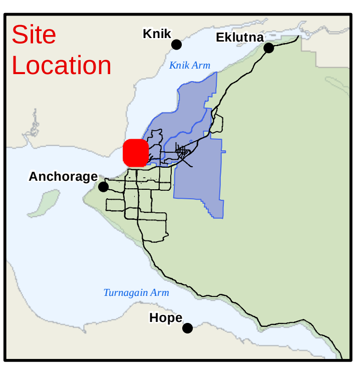


Image Source: AeroMetric 2009 & 2012



Borrow Pit Area
Port Expansion Area
Port Boundary
JBER Boundary
Land Use Control Boundary
Building
Paved Road
Beluga Critical Habitat Exclusion Area
CERCLA Site Boundary

All Locations Are Approximate

0 500 1,000 1,500 2,000
Feet

WGS 1984 UTM Zone 6N

N

LF004 AND WP014 CERCLA SITES AND
PORT OF ANCHORAGE EXPANSION AREA

JOINT BASE ELMENDORF-RICHARDSON, ALASKA

	DATE:	PROJECT MANAGER:	FIGURE NO:
JACOBS	05 MAR 2014	K. MAHER	A-3

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APPENDIX B

Cleanup Levels, Toxicity, and Risk Evaluation

APPENDIX B: CLEANUP LEVELS, TOXICITY, AND RISK EVALUATION

The effects of changes in standards used at the time of remedy selection that may impact the protectiveness of the remedy were evaluated as part of the technical assessment of the five-year review at Joint-Base Elmendorf-Richardson (JBER), former Elmendorf Air Force Base (JBER-E). The evaluation is explained in Section 7.0 of this five-year review report. The evaluation is completed in a step-wise process documented in Tables B-1 through B-3. Additionally, new toxicity data was reviewed in Table B-4 to evaluate potential for additional compounds to present a concern regarding the protectiveness of the remedy.

The first step in this process determined whether any contaminants of potential concern (COPC) have new or changed standards since the time of the Records of Decision (ROD) or since the last five-year review (Table B-1). All compounds identified as COPCs in the ROD are presented in Table B-1 and the table, therefore, includes more compounds than have been presented in previous five-year reviews. If a new or more stringent standard was identified, the COPC was then evaluated in Table B-2 by comparing the current applicable standard with maximum detected levels or more recent applicable concentrations. Finally, if the relevant concentration exceeded the new or changed standards, a new risk evaluation was calculated for that compound and the results are presented in Table B-3.

For COPCs with a new ADEC standard, cancer risks and non-cancer hazards were calculated using Equations 1 and 2 from the ADEC Cleanup Levels Guidance for groundwater and surface water and Equations 3, 4, 7, and 8 for soils (ADEC, 2008). Note that Equations 3 and 4 (for soils) represent the ingestion pathway, and Equations 7 and 8 represent the inhalation pathway. Therefore, the pathway equation that resulted in the most conservative cleanup level was used to estimate health risks in Table B-3.

In order to evaluate whether the remedy remains protective, the risk/hazard calculations were compared to ADEC's risk management level of 1×10^{-5} for carcinogens and a hazard quotient of 1 for noncarcinogens. Discussions also note whether the risk falls within the U.S. Environmental Protection Agency (EPA) management decision risk range of 1×10^{-4} to 1×10^{-6} for carcinogens.

Additionally, Table B-4 summarizes the evaluation of new or revised toxicity data published during this review period that would cause additional compounds or requirements to become a potential protectiveness concern. Risks and hazards were calculated for these compounds using the new reference doses and cancer slope factors. A more detailed discussion of the results of this evaluation is included in Section 7.0 of the five-year review report.

ADEC Cleanup Levels used for Soil

For soils, 18 AAC 75, Table B1 Method Two, under 40-inch zone migration to groundwater, applies for all compounds except diesel-range organics (DRO), gasoline-range organics (GRO), and residual-range organics (RRO) (see Table B-1, note i).

Cleanup Levels used for Groundwater and Surface Water

For water, the strictest of Title 18 of the Alaska Administrative Code (AAC), Chapter 70 and 18 AAC 75 was used for State cleanup levels (origin of State criteria clarified by alpha notation following the criteria, provided on the following page).

Groundwater Criteria

- 18 AAC 75, Table C, Alaska Oil and Hazardous Substances Pollution Control Cleanup Regulations **[denoted with an (A) in the table]**
- 40 CFR 141

Surface Water Criteria

- 18 AAC 70, Alaska Water Quality Standards **[denoted with a (B) in the table]**
- 40 CFR 131

Acronyms and Abbreviations used throughout this appendix include the following:

µg/L	micrograms per liter
AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
BTEX	benzene, toluene, ethylbenzene, and xylenes
CFR	Code of Federal Regulations
COC	contaminant of concern
COPC	contaminant of potential concern
DRO	diesel-range organics
GRO	gasoline-range organics
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
N/A	not applicable
NS	not sampled
ND	not detected
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
RAO	remedial action objective
ROD	Record of Decision
RRO	residual-range organics
TAH	total aromatic hydrocarbons
TAqH	total aqueous hydrocarbons
TCE	trichloroethene
TFH	total fuel hydrocarbons
TPH	total petroleum hydrocarbons
TTHM	total trihalomethanes

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Table B-1
Evaluation of Changes in Chemical-Specific Standards

Operable Unit (matrix and units)	**COPCs (Final ROD COCs in bold)**	**ROD-Established RAO for COCs or Former Standard from previous review period**	**Current Federal MCL**	**Current Alaska Cleanup Level**	**Is There A Newly Promulgated Cleanup Level Since Previous Review?**	**Is the New Level More Stringent than the Previous Standard?**
OU1 (Groundwater) µg/L	1,1,2,2-Tetrachloroethane	4	--	4.3 (A)	Yes	No
	1,2-Dibromoethane	0.05	0.05	0.05 (A)	No	N/A
	Arsenic	76	10	10 (A)	Yes	**Yes**
	Barium	2000	2,000	2,000 (A)	No	N/A
	Benzene	5	5	5 (A)	No	N/A
	Beryllium	4	4	4 (A)	No	N/A[a]
	bis(2-ethylhexyl)phthalate	6	6	6 (A)	No	N/A
	cis 1,2-Dichloroethene	70	70	70 (A)	No	N/A
	Fluoride	4,000	4,000	--	No	N/A[a]
	Lead	15	15	15	No	N/A
	Manganese	9,100	--	50[b]	No	N/A
	Methylethylketone	--	--	22,000	Yes	**Yes**
	Nickel	100	--	100	No	N/A[a]
	PCB	0.5	0.5	0.5 (A)	No	N/A
	Tetrachloroethene	5	5	5 (A)	No	N/A
	Toluene	1000	1,000	1,000 (A)	No	N/A
	Trichloroethene (TCE)	5	5	5 (A)	No	N/A
	Vinyl chloride	2	2	2 (A)	No	N/A

Table B-1
Evaluation of Changes in Chemical-Specific Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD-Established RAO for COCs or Former Standard from previous review period	Current Federal MCL	Current Alaska Cleanup Level	Is There A Newly Promulgated Cleanup Level Since Previous Review?	Is the New Level More Stringent than the Previous Standard?
OU1 (Surface Water) µg/L	TPH (TAH)	10[c]	--	10[c] (B)	No	N/A
OU1 (Soil) mg/kg	Benzo(a)anthracene	6	--	3.6	Yes	**Yes**
	Benzo(b)fluoranthene	4.9	--	4.9	No	N/A[a]
	Benzo(k)fluoranthene	110	--	49	Yes	Yes
	bis(2-ethylhexyl)phthalate	590	--	13	Yes	**Yes**
	2-Methynaphthalene	6.1	--	6.1	No	N/A[a]
	Antimony	3.6	--	3.6	No	N/A[a]
	Arsenic	3.9	--	3.9	No	N/A[a]
	Barium	1,100	--	1,100	No	N/A[a]
	Cadmium	5.0	--	5.0	No	N/A[a]
	Chrysene	360	--	360	No	N/A[a]
	Copper	460	--	460	No	N/A[a]
	Lead	400	--	400	No	N/A
	Mercury	1.4	--	1.4	No	N/A[a]
	Zinc	4,100	--	4,100	No	N/A[a]

Table B-1
Evaluation of Changes in Chemical-Specific Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD-Established RAO for COCs or Former Standard from previous review period	Current Federal MCL	Current Alaska Cleanup Level	Is There A Newly Promulgated Cleanup Level Since Previous Review?	Is the New Level More Stringent than the Previous Standard?
OU1 (Soil) mg/kg *(Continued)*	PCB (Aroclor 1260)	1	--	1	No	N/A[a]
	TPH	--	--	--	No	N/A
	Beryllium	42	--	42	No	N/A[a]
	Sodium	--	--	--	No	N/A
OU2 (Groundwater) µg/L	**Benzene**	5	5	5 (A)	No	N/A
	Ethylbenzene	700	700	700 (A)	No	N/A
	Toluene	1,000	1,000	1,000 (A)	No	N/A
	Xylenes, total	10,000	10,000	10,000 (A)	No	N/A
	1,1,2,2-Tetrachloroethane	4	--	4.3 (A)	Yes	No
	2-Methylnaphthalene	--	--	150 (A)	Yes	**Yes**
	4-Methylphenol	--	--	180 (A)	Yes	**Yes**
	Naphthalene	700	--	730 (A)	Yes	No
	bis(2-ethylhexyl)phthalate	6	6	6 (A)	No	N/A
	Chloroform	100	70	140 (A)	Yes	**Yes**
	TPH	--	--	-- (A)	No	No
	Nitrate (as N)	10,000	10,000	--	No	No
	Antimony	6	6	6 (A)	No	N/A

Table B-1
Evaluation of Changes in Chemical-Specific Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD-Established RAO for COCs or Former Standard from previous review period	Current Federal MCL	Current Alaska Cleanup Level	Is There A Newly Promulgated Cleanup Level Since Previous Review?	Is the New Level More Stringent than the Previous Standard?
OU2 (Groundwater) µg/L *(Continued)*	**Arsenic**[1]	10[d]	10	10 (A)	No	No
	Beryllium[1]	4[d]	4	4 (A)	No	N/A
	Cadmium	5	5	5 (A)	No	N/A
	Lead	15	15	15 (A)	No	No
	Manganese	50[b]	--	50[b]	No	No
	Nickel	100	--	100 (A)	No	N/A
	Vanadium	260	--	260 (A)	No	N/A
	Chromium	100	100	100 (A)	No	N/A
	Barium	2,000	2,000	2,000 (A)	No	N/A
	Thallium[1]	2[d]	2	2 (A)	No	N/A
	Methylene Chloride	5	5	5 (A)	No	N/A
	Trichlorofluoromethane	--	--	11,000 (A)	Yes	**Yes**
	Ethylene dibromide (1,2-Dibromoethane)	0.05	0.05	0.05 (A)	No	N/A

Table B-1
Evaluation of Changes in Chemical-Specific Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD-Established RAO for COCs or Former Standard from previous review period	Current Federal MCL	Current Alaska Cleanup Level	Is There A Newly Promulgated Cleanup Level Since Previous Review?	Is the New Level More Stringent than the Previous Standard?
OU2 (Surface Water) µg/L	**Benzene**[2]	10[e]	12	5[c] (B)	No	No
	Toluene	10[e]	3,100	1,000[c] (B)	No	No
	Ethylbenzene	10[e]	6,800	700[c] (B)	No	No
	Xylenes, total	10[e]	--	10,000[c] (B)	No	No
	1,2-Dichloroethane	5	3.8	5 (B)	No	No
	Arsenic[1]	50[d]	--	50 (A)	No	N/A
	Manganese	--	--	50[b]	Yes	**Yes**
	Lead	--	--	15 (A)	Yes	**Yes**
	Thallium[1]	2[d]	--	2 (A)	No	N/A
	Diesel (TAqH)	15[f]	--	15 (B)	No	N/A
	Gasoline (TAqH)	15[f]	--	15 (B)	No	N/A
OU4 (Groundwater) µg/L	Diesel (DRO)	1,500	--	1,500 (A)	No	N/A
	Benzene	5	5	5 (A)	No	N/A
	Ethylbenzene	700	700	700 (A)	No	N/A
	Toluene	1,000	1,000	1,000 (A)	No	N/A
	Xylenes, total	10,000	10,000	10,000 (A)	No	N/A
	1,1,1-Trichloroethane	200	200	200 (A)	No	N/A

Table B-1
Evaluation of Changes in Chemical-Specific Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD-Established RAO for COCs or Former Standard from previous review period	Current Federal MCL	Current Alaska Cleanup Level	Is There A Newly Promulgated Cleanup Level Since Previous Review?	Is the New Level More Stringent than the Previous Standard?
OU4 (Groundwater) µg/L *(Continued)*	1,1,2-Trichloroethane	5	5	5 (A)	No	N/A
	1,1-Dichloroethane	3,650	--	7,300 (A)	Yes	No
	1,1-Dichloroethene	7	7	7 (A)	No	N/A
	1,2-Dichlorobenzene	600	600	600 (A)	No	N/A
	1,2-Dichloroethane	5	5	5 (A)	No	N/A
	1,3-Dichlorobenzene	600	600[g]	3,300 (A)	Yes	No
	1,4-Dichlorobenzene (para-Dichlorobenzene)	75	75	75 (A)	No	N/A
	2-Methylnaphthalene	--	--	150 (A)	Yes	**Yes**
	2-Methylphenol (o-cresol)	1,800	--	1,800 (A)	No	N/A
	4-Methylphenol (p-cresol)	--	--	180 (A)	Yes	**Yes**
	Acenaphthene	2,200	--	2,200 (A)	No	N/A
	Acetone	3,650	--	3,300 (A)	Yes	**Yes**
	Benzoic acid	146,000	--	150,000 (A)	Yes	No
	Carbon Tetrachloride	5	5	5 (A)	No	N/A
	Chloroethane	--	--	290 (A)	Yes	**Yes**
	Chloroform (TTHM)	100	80[h]	140 (A)	No	N/A

Table B-1
Evaluation of Changes in Chemical-Specific Standards (Continued)

Operable Unit (matrix and units)	**COPCs (Final ROD COCs in bold)**	**ROD-Established RAO for COCs or Former Standard from previous review period**	**Current Federal MCL**	**Current Alaska Cleanup Level**	**Is There A Newly Promulgated Cleanup Level Since Previous Review?**	**Is the New Level More Stringent than the Previous Standard?**
OU4 (Groundwater) µg/L *(Continued)*	Chloromethane	--	--	66 (A)	Yes	**Yes**
	cis-1,2-Dichloroethene	70	70	70 (A)	No	N/A
	cis-1,3-Dichloropropene	--	--	8.5 (A)	Yes	**Yes**
	Delta-BHC	--	--	--	No	N/A
	Dieldrin	0.05	--	0.053 (A)	Yes	No[a]
	Fluorene	1,460	--	1,500 (A)	Yes	No
	Methyl ethyl ketone	--	--	22,000 (A)	Yes	**Yes**
	Naphthalene	700	--	730 (A)	Yes	No
	Phenol	22,000	--	11,000 (A)	Yes	**Yes**
	Tetrachloroethene (PCE)	5	5	5 (A)	No	N/A
	trans-l,2-Dichloroethene	100	100	100 (A)	No	N/A
	Trichloroethene (TCE)	5	5	5 (A)	No	N/A
	Trichlorofluoromethane	--	--	11,000 (A)	Yes	**Yes**
	Vinyl chloride	2	2	2 (A)	No	N/A

Table B-1
Evaluation of Changes in Chemical-Specific Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD-Established RAO for COCs or Former Standard from previous review period	Current Federal MCL	Current Alaska Cleanup Level	Is There A Newly Promulgated Cleanup Level Since Previous Review?	Is the New Level More Stringent than the Previous Standard?
OU4 (Soil) mg/kg	**Diesel (DRO)**	2,000	--	2,000[i]	No	N/A
	Jet fuel (DRO)	2,000	--	2,000[i]	No	N/A
	Kerosene (DRO)	2,000	--	2,000[i]	No	N/A
	Gasoline (GRO)	1,000	--	1,000[i]	No	N/A
	BTEX	100	--	--[j]	No	N/A
	Benzene	0.02	--	0.025	Yes	No
	Ethylbenzene	5.5	--	6.9	Yes	No
	Toluene	5.4	--	6.5	Yes	No
	Xylenes, total	78	--	63	Yes	**Yes**
	1,1,1-Trichloroethane	1.0	--	0.82	Yes	**Yes**
	2-Methylnaphthalene	6.1	--	6.1	No	N/A[a]
	4,4-DDD	35	--	7.2	Yes	**Yes**
	4,4-DDE	24	--	5.1	Yes	**Yes**
	4,4-DDT	24	--	7.3	Yes	**Yes**
	4-Methylphenol	1.5	--	1.5	No	N/A[a]
	Acenaphthene	210	--	180	Yes	**Yes**
	Acetone	88	--	88	No	N/A[a]

Table B-1
Evaluation of Changes in Chemical-Specific Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD-Established RAO for COCs or Former Standard from previous review period	Current Federal MCL	Current Alaska Cleanup Level	Is There A Newly Promulgated Cleanup Level Since Previous Review?	Is the New Level More Stringent than the Previous Standard?
OU4 (Soil) mg/kg *(Continued)*	Aldrin	0.5	--	0.070	Yes	**Yes**
	alpha-BHC	0.0026	--	0.0064	Yes	No
	Anthracene	4,300	--	3,000	Yes	**Yes**
	Benzo(a)anthracene[1]	6[d]	--	3.6	Yes	**Yes**
	Benzo(a)pyrene[1]	1[d]	--	2.1	Yes	No
	Benzo(b)fluoranthene[1]	11[d]	--	12	Yes	No
	Benzo(g,h,i)perylene	1,400	--	1,400	No	N/A[a]
	Benzo(k)fluoranthene[1]	110[d]	--	49	Yes	**Yes**
	beta-BHC	0.009	--	0.022	Yes	No
	bis(2-ethylhexyl)phthalate	590	--	13	Yes	**Yes**
	Butylbenzylphthalate	5,600	--	920	Yes	**Yes**
	Chromium	48.44	--	25	Yes	**Yes**
	Chrysene	620	--	360	Yes	**Yes**
	cis-l,2-Dichloroethene (1,2-DCE)	0.2	--	0.24	Yes	No
	Cobalt	19.52[k]	--	--	No	N/A
	Copper	460	--	460	No	N/A[a]

Table B-1
Evaluation of Changes in Chemical-Specific Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD-Established RAO for COCs or Former Standard from previous review period	Current Federal MCL	Current Alaska Cleanup Level	Is There A Newly Promulgated Cleanup Level Since Previous Review?	Is the New Level More Stringent than the Previous Standard?
OU4 (Soil) mg/kg *(Continued)*	Cyanide	27	--	27	No	N/A
	Dibenzo(a,h)anthracene[1]	1[d]	--	4.0	Yes	No
	Dibenzofuran	11	--	11	No	N/A[a]
	Di-n-butylphthalate	1,700	--	80	Yes	**Yes**
	Endosulfan sulfate	64	--	64	No	N/A[a]
	Endrin	0.3	--	0.29	Yes	**Yes**
	Fluoranthene	2,10	--	1,400	Yes	**Yes**
	Fluorene	270	--	220	Yes	**Yes**
	gamma-BHC (Lindane)	0.003	--	0.0095	Yes	No
	Heptachlor	0.08	--	0.28	Yes	No
	Indeno(1,2,3-c,d)pyrene[1]	11[d]	--	41	Yes	No
	Isophorone	3	--	3.1	Yes	No
	Lead	400	--	400	No	N/A
	Magnesium	--	--	--	No	N/A
	Methylene chloride	0.015	--	0.016	Yes	No
	Methyl ethyl ketone	59	--	59	No	N/A[a]
	Molybdenum	--	--	--	No	N/A

Table B-1
Evaluation of Changes in Chemical-Specific Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD-Established RAO for COCs or Former Standard from previous review period	Current Federal MCL	Current Alaska Cleanup Level	Is There A Newly Promulgated Cleanup Level Since Previous Review?	Is the New Level More Stringent than the Previous Standard?
OU4 (Soil) mg/kg *(Continued)*	Naphthalene	21	--	20	Yes	**Yes**
	Nickel	51[k]	--	1.4	Yes	**Yes**
	PCB-1260[1]	1[d]	--	1	No	N/A
	Phenanthrene	3,000	--	3,000	No	N/A[a]
	Pyrene	1,500	--	1,000	Yes	**Yes**
	Selenium	0.54	--	3.4	Yes	No
	Thallium	--	--	1.9	Yes	**Yes**
	Tetrachloroethene (PCE)	0.3	--	0.024	Yes	**Yes**
	Trichloroethene (TCE)	0.020	--	0.020	No	N/A
	Vanadium	710	--	3,400	Yes	No
	Zinc	9,100	--	4,100	Yes	**Yes**
OU5 (Groundwater) µg/L	JP-4 (RRO)	1,100	--	1,100 (A)	No	N/A
	TFH-Diesel (TAH)[3]	10	--	10 (B)	No	N/A
	TFH-Gas (TAqH)[3]	10	--	15 (B)	Yes	No
	Benzene	5	5	5 (A)	No	N/A
	Ethylbenzene	700	700	700 (A)	No	N/A
	Toluene	1,000	1,000	1,000 (A)	No	N/A

Table B-1
Evaluation of Changes in Chemical-Specific Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD-Established RAO for COCs or Former Standard from previous review period	Current Federal MCL	Current Alaska Cleanup Level	Is There A Newly Promulgated Cleanup Level Since Previous Review?	Is the New Level More Stringent than the Previous Standard?
OU5 (Groundwater) µg/L *(Continued)*	Xylenes, total	10,000	10,000	10,000 (A)	No	N/A
	1,1,1-Trichloroethane	200	200	200 (A)	No	N/A
	1,1,2,2-Tetrachloroethane	4	--	4.3 (A)	Yes	No
	1,1-Dichloroethane	3,650	--	7,300 (A)	Yes	No
	2-Methylnaphthalene	--	--	150 (A)	Yes	**Yes**
	Aluminum	50-200	--	50-200[b]	No	N/A
	Barium	2,000	2,000	2,000 (A)	No	N/A
	bis(2-ethylhexyl)phthalate	6	6	6 (A)	No	N/A
	Chloroethane	--	--	290 (A)	Yes	**Yes**
	Diethyl phthalate	29,000	--	29,000 (A)	No	N/A
	Di-n-butyl phthalate	3,650	--	3,700 (A)	Yes	No
	Manganese	50	--	50[b]	No	N/A
	Naphthalene	700	--	730 (A)	Yes	No
	n-Nitrosodiphenylamine	170	--	170 (A)	No	N/A
	Selenium	50	50	50 (A)	No	N/A
	Trichloroethene (TCE)	5	5	5 (A)	No	N/A
	Vanadium	260	--	260 (A)	No	N/A

Table B-1
Evaluation of Changes in Chemical-Specific Standards (Continued)

Operable Unit (matrix and units)	**COPCs (Final ROD COCs in bold)**	**ROD-Established RAO for COCs or Former Standard from previous review period**	**Current Federal MCL**	**Current Alaska Cleanup Level**	**Is There A Newly Promulgated Cleanup Level Since Previous Review?**	**Is the New Level More Stringent than the Previous Standard?**
OU5 (Surface Water) µg/L	l,l,l-Trichloroethane	200	--	200 (B)	No	N/A
	1,1-Dichloroethane	--	--	7.3 (B)	Yes	**Yes**
	1,2-Dichloroethane	5	3.8	5 (B)	No	N/A
	1,1,2,2-Tetrachloroethane	110	1.7	--	Yes	**Yes**
	4-Methylphenol	--	--	180 (A)	Yes	**Yes**
	Benzene	5	12	5 (B)	No	N/A
	Bromomethane	--	--	51 (A)	Yes	**Yes**
	Ethylbenzene	700	3,100	700 (B)	No	N/A
	Toluene	1,000	6,800	1,000 (B)	No	N/A
	Xylenes, total	10,000	--	10,000 (B)	No	N/A
	Naphthalene (TAqH)	700	--	700[c] (B)	No	N/A
	Trichloroethene (TCE)	5	810	5 (B)	No	N/A
	trans-1,2-Dichloroethene	100	--	100 (B)	No	N/A
	Sheen	No Sheen	--	No Sheen (B)	No	N/A
	TFH-Gas (TAH/TAqH)[3]	10 [c]	--	10/15[c] (B)	No	N/A
	JP-4 (TAH)	10 [c]	--	10[c] (B)	No	N/A

Table B-1
Evaluation of Changes in Chemical-Specific Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD-Established RAO for COCs or Former Standard from previous review period	Current Federal MCL	Current Alaska Cleanup Level	Is There A Newly Promulgated Cleanup Level Since Previous Review?	Is the New Level More Stringent than the Previous Standard?
OU5 (Soil) mg/kg	JP-4 (RRO)	2,000	--	2,000[i]	No	N/A
	TFH-Gas (GRO)	500	--	500[i]	No	N/A
	TFH-Diesel (DRO)	1,000 [c]	--	1,000[i]	No	N/A
	Benzene	0.02	--	0.025	Yes	No
	Ethylbenzene	5.5	--	6.9	Yes	No
	Toluene	5.4	--	6.5	Yes	No
	Xylenes, total	78	--	63	Yes	**Yes**
	Anthracene	4,300	--	3,000	Yes	**Yes**
	Arsenic	2	--	3.9	Yes	No
	Barium	1,100	--	1,100	No	N/A
	Benzo(a)anthracene	6	--	3.6	Yes	**Yes**
	Benzo(a)pyrene	1	--	3.6	Yes	No
	Benzo(b)fluoranthene	11	--	12	Yes	No
	Benzo(k)fluoranthene	110	--	49	Yes	**Yes**
	Beryllium	42	--	42	No	N/A
	bis(2-ethylhexyl)phthalate	590	--	13	Yes	**Yes**
	Cadmium	5	--	5.0	No	N/A

Table B-1
Evaluation of Changes in Chemical-Specific Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD-Established RAO for COCs or Former Standard from previous review period	Current Federal MCL	Current Alaska Cleanup Level	Is There A Newly Promulgated Cleanup Level Since Previous Review?	Is the New Level More Stringent than the Previous Standard?
OU5 (Soil) mg/kg *(Continued)*	Chromium	26	--	25	Yes	**Yes**
	Chrysene	620	--	360	Yes	**Yes**
	Copper	460	--	460	No	N/A[a]
	Diethyl phthalate	190	--	130	Yes	**Yes**
	Di-n-butyl phthalate	1,700	--	80	Yes	**Yes**
	Fluoranthene	2,100	--	1,400	Yes	**Yes**
	Indeno(1,2,3,-cd)pyrene	11	--	4.9	Yes	**Yes**
	Lead	400	--	400	No	N/A
	Mercury	1.4	--	1.4	No	N/A
	Naphthalene	21	--	20	Yes	**Yes**
	Pyrene	1,500	--	1,000	Yes	**Yes**
	Selenium	3.5	--	3.4	Yes	**Yes**
	Silver	21	--	11.2	Yes	**Yes**
	Thallium	--	--	1.9	Yes	**Yes**
	Zinc	9,100	--	4,100	Yes	**Yes**

Table B-1
Evaluation of Changes in Chemical-Specific Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD-Established RAO for COCs or Former Standard from previous review period	Current Federal MCL	Current Alaska Cleanup Level	Is There A Newly Promulgated Cleanup Level Since Previous Review?	Is the New Level More Stringent than the Previous Standard?
OU6 (Groundwater) μg/L	Jet fuel (JP-4; DRO)	1,500	--	1,500 (A)	No	N/A
	Gasoline (GRO)	1,300	--	2,200 (A)	Yes	No
	Benzene	5	5	5 (A)	No	N/A
	Ethylbenzene	700	700	700 (A)	No	N/A
	Toluene	1,000	1,000	1,000 (A)	No	N/A
	Xylenes, total	10,000	10,000	10,000 (A)	No	N/A
	1,1,1-Trichloroethane	200	200	200 (A)	No	N/A
	1,1,2,2-Tetrachloroethane	4[1]	--	4.3 (A)	Yes	No
	1,1,2-Trichloroethane	5	5	5 (A)	No	N/A
	1,1-Dichloroethane	3,650	--	7,300 (A)	Yes	No
	1,1-Dichloroethene	7	7	7 (A)	No	N/A
	1,2-Dichlorobenzene	600	600	600 (A)	No	N/A
	1,2-Dichloroethane	5	5	5 (A)	No	N/A
	1,2-Dichloropropane	5	5	5 (A)	No	N/A
	2-Butanone (MEK)	--	--	22,000 (A)	Yes	**Yes**
	2,4-Dimethylphenol	700	--	730 (A)	Yes	No
	2-Hexanone	--	--	--	No	No

Table B-1
Evaluation of Changes in Chemical-Specific Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD-Established RAO for COCs or Former Standard from previous review period	Current Federal MCL	Current Alaska Cleanup Level	Is There A Newly Promulgated Cleanup Level Since Previous Review?	Is the New Level More Stringent than the Previous Standard?
OU6 (Groundwater) µg/L *(Continued)*	2-Methylnaphthalene	--	--	150 (A)	Yes	**Yes**
	2-Methylphenol (o-cresol)	1,800	--	1,800 (A)	No	N/A
	4-Methyl-2-pentanone (MIBK)	--	--	2,900 (A)	Yes	**Yes**
	4,4-DDD	3.6	--	3.5 (A)	Yes	**Yes**
	4,4-DDE	2.5	--	2.5 (A)	No	N/A
	4,4-DDT	2.5	--	2.5 (A)	No	N/A
	Acenaphthene	2,200	--	2,200 (A)	No	N/A
	Acenaphthylene	--	--	2,200 (A)	Yes	**Yes**
	Acetone	3,645	--	33,000 (A)	Yes	No
	Aldrin	0.05	--	0.05 (A)	No	N/A
	alpha-BHC (alpha-Hexachlorocyclohexane)	0.1	--	0.14 (A)	Yes	No
	Anthracene	11,000	--	11,000 (A)	No	N/A
	Antimony	6	6	6 (A)	No	N/A
	Arsenic	50	10	10 (A)	Yes	**Yes**
	Barium	2000	2,000	2,000 (A)	No	N/A

Table B-1
Evaluation of Changes in Chemical-Specific Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD-Established RAO for COCs or Former Standard from previous review period	Current Federal MCL	Current Alaska Cleanup Level	Is There A Newly Promulgated Cleanup Level Since Previous Review?	Is the New Level More Stringent than the Previous Standard?
OU6 (Groundwater) µg/L *(Continued)*	Benzo(b)fluoranthene	0.2	--	1.2 (A)	Yes	No
	Benzoic acid	146,000	--	150,000 (A)	Yes	No
	Beryllium	4	4	4 (A)	No	N/A
	beta-BHC (beta-Hexachlorocyclohexane)	0.47	--	0.47 (A)	No	N/A
	bis(2-ethylhexyl)phthalate	6	6	6 (A)	No	N/A
	Cadmium	5	5	5 (A)	No	N/A
	Carbon tetrachloride	5	5	5 (A)	No	N/A
	Chlorobenzene (Monochlorobenzene)	100	100	100 (A)	No	N/A
	Chloroethane	--	--	290 (A)	Yes	**Yes**
	Chloroform (TTHM)	100	80[h]	140 (A)	Yes	No
	Chloromethane	--	--	66 (A)	Yes	**Yes**
	Chromium	100	100	100 (A)	No	N/A
	Chrysene	0.2	--	120 (A)	Yes	No
	cis-1,2-Dichloroethene	70	70	70 (A)	No	N/A
	Cobalt	--	--	--	No	No
	Copper	1,300	1,300	1,000 (A)	Yes	**Yes**

Table B-1
Evaluation of Changes in Chemical-Specific Standards (Continued)

Operable Unit (matrix and units)	**COPCs (Final ROD COCs in bold)**	**ROD-Established RAO for COCs or Former Standard from previous review period**	**Current Federal MCL**	**Current Alaska Cleanup Level**	**Is There A Newly Promulgated Cleanup Level Since Previous Review?**	**Is the New Level More Stringent than the Previous Standard?**
OU6 (Groundwater) µg/L *(Continued)*	Dieldrin	0.05	--	0.053 (A)	Yes	No
	Diethylphthalate	29,000	--	29,000 (A)	No	N/A
	Dimethylphthalate	--	--	370,000 (A)	Yes	**Yes**
	Di-n-octylphthalate	700	--	1,500 (A)	Yes	No[a]
	Endrin	2	2	2	No	N/A
	Endosulfan I	--	--	220 (A)	Yes	**Yes**
	Fluoranthene	1,460	--	1,500 (A)	Yes	No
	Fluorene	1,460	--	1,500 (A)	Yes	No
	gamma-BHC (Lindane)	0.2	0.2	0.2 (A)	No	N/A
	Heptachlor	0.4	0.4	0.4 (A)	No	N/A
	Heptachlor epoxide	0.2	0.2	0.2 (A)	No	N/A
	Lead	15	15	15 (A)	No	N/A
	Manganese	50[b]	--	50[b]	No	No
	Methylene chloride (Dichloromethane)	5	5	5 (A)	No	N/A
	Naphthalene	700	--	730 (A)	Yes	No
	Nickel	100	--	100 (A)	No	N/A

Table B-1
Evaluation of Changes in Chemical-Specific Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD-Established RAO for COCs or Former Standard from previous review period	Current Federal MCL	Current Alaska Cleanup Level	Is There A Newly Promulgated Cleanup Level Since Previous Review?	Is the New Level More Stringent than the Previous Standard?
OU6 (Groundwater) µg/L *(Continued)*	Phenanthrene	--	--	11,000 (A)	Yes	**Yes**
	Phenol	22,000	--	11,000 (A)	Yes	**Yes**
	Pyrene	1,100	--	1,100 (A)	No	N/A
	Selenium	50	50	50 (A)	No	N/A
	Tetrachloroethene (PCE)	5	5	5 (A)	No	N/A
	trans-1,2-Dichloroethene	100	100	100 (A)	No	N/A
	Trichloroethene (TCE)	5	5	5 (A)	No	N/A
	Vanadium	260	--	260 (A)	No	N/A
	Vinyl chloride	2	2	2 (A)	No	N/A
	Zinc	11,000	--	5,000 (A)	Yes	**Yes**
OU6 (Surface Water) µg/L	Gasoline (TAqH)	15 [c]	--	15[c] (B)	No	N/A
	TAH	10 [c]	--	10[c] (B)	No	N/A
	Benzene	5	710	5 (B)	No	N/A
	Ethylbenzene	700	3,100	700 (B)	No	N/A
	Toluene	1,000	6,800	1,000 (B)	No	N/A
	Xylenes, total	10,000	--	10,000 (B)	No	N/A
	1,2-Dichloroethane	5	990	5 (B)	No	N/A

Table B-1
Evaluation of Changes in Chemical-Specific Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD-Established RAO for COCs or Former Standard from previous review period	Current Federal MCL	Current Alaska Cleanup Level	Is There A Newly Promulgated Cleanup Level Since Previous Review?	Is the New Level More Stringent than the Previous Standard?
OU6 (Surface Water) µg/L *(Continued)*	Arsenic	20	--	10 (B)	Yes	**Yes**
	Barium	2,000	--	2,000 (B)	No	N/A
	Benzo(b)fluoranthene	0.31	0.31	--	No	N/A
	Benzo(k)fluoranthene	0.31	0.31	--	No	N/A
	Beryllium	4	--	4 (B)	No	N/A
	Chromium	100	--	100 (B)	No	N/A
	Chrysene	0.31	0.31	120 (B)	No	N/A
	Nickel	100	--	100 (B)	No	N/A
	Phenol	4,600,000	4,600,000	11,000 (B)	Yes	**Yes**
	Styrene	100	--	100 (B)	No	N/A
OU6 (Soil)[4] mg/kg	**Diesel (DRO; Site SD015)**	2,000	--	2,000[i]	No	N/A
	Gasoline (GRO; Site SD015)	1,000	--	1,000[i]	No	N/A
	Diesel (DRO; Other Sites)	1,000	--	1,000[i]	No	N/A
	Gasoline(GRO; Other Sites)	500	--	500[i]	No	N/A
	Jet fuel (DRO)	2,000	--	2,000[i]	No	N/A
	Kerosene (DRO)	2,000	--	2,000[i]	No	N/A
	BTEX	100	--	--	No	No

Table B-1
Evaluation of Changes in Chemical-Specific Standards (Continued)

Operable Unit (matrix and units)	**COPCs (Final ROD COCs in bold)**	**ROD-Established RAO for COCs or Former Standard from previous review period**	**Current Federal MCL**	**Current Alaska Cleanup Level**	**Is There A Newly Promulgated Cleanup Level Since Previous Review?**	**Is the New Level More Stringent than the Previous Standard?**
OU6 (Soil)[4] mg/kg *(Continued)*	Benzene	0.02	--	0.025	Yes	No[m]
	Ethylbenzene	5.5	--	6.9	Yes	No
	Toluene	5.4	--	6.5	Yes	No
	Xylenes, total	10	--	63	Yes	No
	1,1,1-Trichloroethane	1.0	--	0.82	Yes	**Yes**
	1,1,2,2-Tetrachloroethane	0.017	--	0.017	No	N/A
	1,1-Dichloroethane	12	--	25	Yes	No
	1,2,4-Trichlorobenzene	2	--	0.85	Yes	**Yes**
	1,2-Dichlorobenzene	7	--	5.1	Yes	**Yes**
	1,3-Dichlorobenzene	--	--	28	Yes	**Yes**
	1,4-Dichlorobenzene	0.8	--	0.64	Yes	**Yes**
	2-Butanone(MEK)	--	--	59	Yes	**Yes**
	2-Methylnaphthalene	6.1	--	6.1	Yes	**Yes**
	2-Methylphenol (o-cresol)	7	--	15	Yes	No
	4-Methyl-2-pentanone (MIBK)	--	--	8.1	Yes	**Yes**
	4,4-DDD	35	--	7.2	Yes	**Yes**

Table B-1
Evaluation of Changes in Chemical-Specific Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD-Established RAO for COCs or Former Standard from previous review period	Current Federal MCL	Current Alaska Cleanup Level	Is There A Newly Promulgated Cleanup Level Since Previous Review?	Is the New Level More Stringent than the Previous Standard?
OU6 (Soil)[4] mg/kg *(Continued)*	4,4-DDE	24	--	5.1	Yes	**Yes**
	4,4-DDT	24	--	7.3	Yes	**Yes**
	Acetone	10	--	88	Yes	No
	Aldrin	0.5	--	0.070	Yes	**Yes**
	alpha-BHC	0.0026	--	0.0064	Yes	No
	Anthracene	4,300	--	3,000	Yes	**Yes**
	Antimony	3.6	--	3.6	No	N/A
	Arsenic	9.31[k]	--	3.9	Yes	**Yes**
	Barium	196.45[k]	--	1,100	Yes	No
	Benzo(a)anthracene	6	--	3.6	Yes	**Yes**
	Benzo(a)pyrene	1	--	3.6	Yes	No
	Benzo(b)fluoranthene	11	--	4.9	Yes	**Yes**
	Benzo(g,h,i)perylene	1,400	--	1,400	Yes	**Yes**
	Benzo(k)fluoranthene	110	--	49	Yes	**Yes**
	Benzoic acid	390	--	410	Yes	No
	Benzyl alcohol	--	--	--	No	N/A
	Beryllium	0.76[k]	--	42	Yes	No

Table B-1
Evaluation of Changes in Chemical-Specific Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD-Established RAO for COCs or Former Standard from previous review period	Current Federal MCL	Current Alaska Cleanup Level	Is There A Newly Promulgated Cleanup Level Since Previous Review?	Is the New Level More Stringent than the Previous Standard?
OU6 (Soil)[4] mg/kg *(Continued)*	beta-BHC	0.009	--	0.022	Yes	No
	bis(2-ethylhexyl)phthalate	590	--	13	Yes	**Yes**
	Butyl benzyl phthalate	5,600	--	920	Yes	**Yes**
	Cadmium	5	--	5.0	No	N/A
	Chlorobenzene	0.6	--	0.63	Yes	No
	Chloroform	0.34	--	0.46	Yes	No
	Chromium	48.44[k]	--	25	Yes	**Yes**
	Chrysene	620	--	360	Yes	**Yes**
	cis-1,2-Dichloroethene	0.2	--	0.24	Yes	No
	Cobalt	--	--	--	No	N/A
	Copper	460	--	460	No	N/A[a]
	delta-BHC	--	--	--	No	N/A
	Dibenzofuran	--	--	11	Yes	**Yes**
	Dibenzo(a,h)anthracene	1	--	4.0	Yes	No
	Dieldrin	0.015	--	0.0076	Yes	**Yes**
	Diethyl phthalate	190	--	130	Yes	**Yes**
	Dimethyl phthalate	1,400	--	1,100	Yes	**Yes**

Table B-1
Evaluation of Changes in Chemical-Specific Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD-Established RAO for COCs or Former Standard from previous review period	Current Federal MCL	Current Alaska Cleanup Level	Is There A Newly Promulgated Cleanup Level Since Previous Review?	Is the New Level More Stringent than the Previous Standard?
OU6 (Soil)[4] mg/kg *(Continued)*	Di-n-butyl phthalate	1700	--	80	Yes	**Yes**
	Di-n-octyl phthalate	2,000	--	3,800	Yes	No
	Endrin	0.3	--	0.29	Yes	**Yes**
	Endrin Aldehyde	--	--	--	No	N/A
	Fluoranthene	2,100	--	1,400	Yes	**Yes**
	Fluorene	270	--	220	Yes	**Yes**
	gamma-BHC (Lindane)	0.003	--	0.0095	Yes	No
	Heptachlor	0.8	--	0.28	Yes	**Yes**
	Heptachlor epoxide	0.2	--	0.014	Yes	**Yes**
	Indeno(1,2,3,-cd)pyrene	11	--	4.9	Yes	**Yes**
	1,1-Dichloroethene	0.030	--	0.030	No	N/A
	Lead[4]	10.13[k]	--	400	Yes	No
	Manganese	--	--	--	No	N/A
	Methylene chloride	0.015	--	0.21	Yes	No
	Molybdenum	--	--	--	No	N/A
	Naphthalene	21	--	20	Yes	**Yes**
	Nickel	71.79[k]	--	86	Yes	No

Table B-1
Evaluation of Changes in Chemical-Specific Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD-Established RAO for COCs or Former Standard from previous review period	Current Federal MCL	Current Alaska Cleanup Level	Is There A Newly Promulgated Cleanup Level Since Previous Review?	Is the New Level More Stringent than the Previous Standard?
OU6 (Soil)[4] mg/kg *(Continued)*	PCB-1260	1	--	1	No	N/A
	PCB-1254	1	--	1	No	N/A
	Phenanthrene	3,000	--	3,000	No	No
	Pyrene	1,500	--	1,000	Yes	**Yes**
	Selenium	0.54[k]	--	3.4	Yes	No
	Silver	1.68[k]	--	11.2	Yes	No
	Styrene	1.3	--	0.96	Yes	**Yes**
	Tetrachloroethene (PCE)	0.03	--	0.024	Yes	**Yes**
	Thallium	--	--	1.9	Yes	**Yes**
	Trichloroethene (TCE)	0.020	--	0.020	No	N/A
	Vanadium	101.64[k]	--	3,400	No	N/A
	Zinc	90.01[k]	--	4,100	No	N/A
DP098 (Groundwater) µg/L	DRO	1,500	--	1,500 (A)	No	N/A
	GRO	1,300	--	1,300 (A)	No	N/A
	RRO	1,100	--	1,100 (A)	No	N/A
	1,1-Dichloroethene	7	7	7 (A)	No	N/A
	Benzene	5	5	5 (A)	No	N/A

Table B-1
Evaluation of Changes in Chemical-Specific Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD-Established RAO for COCs or Former Standard from previous review period	Current Federal MCL	Current Alaska Cleanup Level	Is There A Newly Promulgated Cleanup Level Since Previous Review?	Is the New Level More Stringent than the Previous Standard?
DP098 (Groundwater) µg/L *(Continued)*	Chloroform (TTHM)	80	80	100 (A)	No	N/A
	Chloromethane	--	--	66	Yes	**Yes**
	cis-1,2-Dichloroethene	70	70	70 (A)	No	N/A
	gamma-BHC (Lindane)	0.2	0.2	0.2 (A)	No	N/A
	Methylene chloride (Dichloromethane)	5	5	5 (A)	No	N/A
	Tetrachloroethene (PCE)	5	5	5 (A)	No	N/A
	trans-1,2-Dichloroethene	100	100	100 (A)	No	N/A
	Trichloroethene (TCE)	5	5	5 (A)	No	N/A
	Vinyl Chloride	2	2	2 (A)	No	N/A
	Xylenes, total	10,000	10,000	10,000(A)	No	N/A
DP098 (Surface Water) µg/L	TAH	10	--	10 (B)	No	N/A
	TAqH	15	--	15 (B)	No	N/A
	Benzo(a)pyrene	0.2	0.31	0.2 (A)	No	N/A
	cis-1,2-Dichloroethene	5	--	70 (A)	No	N/A
	Dibenzo(a,h)anthracene	0.1	0.31	0.12 (A)	No	N/A
	Indeno(1,2,3-cd)pyrene	1	0.31	1.2 (A)	No	N/A
	Trichloroethene (TCE)	5	810	5 (A)	No	N/A

Table B-1
Evaluation of Changes in Chemical-Specific Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD-Established RAO for COCs or Former Standard from previous review period	Current Federal MCL	Current Alaska Cleanup Level	Is There A Newly Promulgated Cleanup Level Since Previous Review?	Is the New Level More Stringent than the Previous Standard?
DP098 (Soil) mg/kg	DRO	250	--	250	No	N/A
	GRO	300	--	300	No	N/A
	RRO	10,000	--	10,000	No	N/A
	1,1-Dichloroethene	0.03	--	0.03	No	N/A
	Benzene	0.02	--	0.025	No	N/A
	cis-1,2-Dichloroethene	0.2	--	0.24	No	N/A
	Tetrachloroethene (PCE)	0.03	--	0.024	No	N/A
	Trichloroethene (TCE)	0.027	--	0.02	No	N/A

Notes:

(Notes continue on next page)

[1] Identified in the ROD as a final COC; however, no cleanup level was assigned to this chemical.

[2] The more stringent cleanup level for benzene was already assessed in a previous five-year review but the value was not moved to the third column because the ROD established RAO for this compound is still applicable.

[3] The OU5 ROD identified TFH-gas and/or TFH-diesel from 18 AAC 70, which have since become outdated. In 1998, an agreement with ADEC and the U.S. Environmental Protection Agency was made to replace the outdated TFH analyses with TAH and TAqH. Because TFH is no longer used, the current criteria shown are for TAH and TAqH and are consistent with current RAOs for OU5.

[4] Updated soil cleanup levels have been evaluated for all soil contaminant detections for all OU6 sites. However, soil COC cleanup levels in the OU6 ROD are applicable to SD015 only, except for lead at LF002. The OU6 ROD did not specify soil COCs for the other sites that comprise OU6.

Table B-1
Evaluation of Changes in Chemical-Specific Standards (Continued)

[a] The analyte was not evaluated during the 2003 and 2008 Five-Year review periods despite being listed as a COPC in the ROD. Therefore, while no change in cleanup level has occurred since the previous review period (2008), the analyte will be listed in Table B-2 for further evaluation.

[b] For groundwater, this is a Secondary Drinking Water MCL from 18 AAC 80. Secondary criteria mainly affect the aesthetic quality of drinking water. For surface water, 18 AAC 70 lists 50 μg/L as the standard for human health consumption of water plus aquatic organisms.

[c] TAH in surface water may not exceed 10 μg/L. TAH consists of BTEX. TAqH in surface water may not exceed 15 μg/L. TAqH consists of TAH and PAH, including naphthalene (700 μg/L is a groundwater standard).

[d] The analyte was identified in the ROD as a COC; however, no cleanup level was assigned. Therefore, the cleanup level from the 2008 five-year review period was utilized to identify any changes in MCLs from the previous review period.

[e] ROD established RAO.

[f] Cleanup levels are based on total hydrocarbons.

[g] The MCL for 1,3-dichlorobenzene (m-) is based on the Federal Drinking Water MCL for 1,2-dichlorobenzene (o-) (U.S. Environmental Protection Agency Drinking Water Standards and Health Advisories Table (2007 [June]).

[h] The total trihalomethanes (TTHM) MCL is 80 ug/L.

[i] This criteria is from 18 AAC 75 Table C for groundwater and Table A1-Method 1 for soils (See agreements in the OU4 and OU6 RODs to use Category D for OU4 sites and OU6 site SD015, and Category C for the other OU6 sites and OU5). Kerosene and Jet Fuel are compared to DRO, as they were in the RODs.

[j] Cleanup standards for BTEX no longer apply, instead cleanup standards are listed for the individual contaminants.

[k] ROD-specified limit based on elevated background concentrations.

[l] The cleanup level for 1,1,2,2-tetrachloroethane was changed in the January 2007 Explanation of Significant Differences for OU6. The cleanup level is now 4 μg/L.

[m] Benzene will be listed in Table B-2 for further evaluation due to the availability of new analytical data for SD015 in 2009 and 2011.

Table B-2
Evaluation of Changes for New, More Stringent, Standards

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD Established RAO for COCs or Former Standard from Previous Review Period (2008)	Current Federal MCL	Current Alaska Cleanup Level	Maximum Detected at ROD	Maximum Detected During Most Recent Sampling Event	New Risk Evaluation Needed?
OU1 (Groundwater) µg/L	Arsenic	76[a]	10	10 (A)	140	--	No[1]
	Beryllium	4	4	4 (A)	3.0	--	No
	Fluoride	4,000	4,000	--	5,200	--	**Yes**
	Methylethylketone	--	--	22,000	290	--	No
	Nickel	100	--	100	310	--	**Yes**
OU1 (Soil) mg/kg	Benzo(a)anthracene	6	--	3.6	0.58	--	No
	Benzo(b)fluoranthene	4.9	--	4.9	0.25	--	No
	Benzo(k)fluoranthene	110	--	49	0.43	--	No
	bis(2-ethylhexyl phthalate	590	--	13	13	--	**Yes**
	2-Methynaphthalene	6.1	--	6.1	1.2	--	No
	Antimony	3.6	--	3.6	14.6	--	**Yes**
	Arsenic	3.9	--	3.9	30.9	--	**Yes**
	Barium	1,100	--	1,100	2,110	--	**Yes**
	Cadmium	5.0	--	5.0	20.6	--	**Yes**
	Copper	460	--	460	135	--	No
	Mercury	1.4	--	1.4	0.3	--	No
	Zinc	4,100	--	4,100	379	--	No

Table B-2
Evaluation of Changes for New, More Stringent, Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD Established RAO for COCs or Former Standard from Previous Review Period (2008)	Current Federal MCL	Current Alaska Cleanup Level	Maximum Detected at ROD	Maximum Detected During Most Recent Sampling Event	New Risk Evaluation Needed?
OU1 (Soil) mg/kg *(Continued)*	Chrysene	360	--	360	0.5	--	No
	PCB (Aroclor 1260)	1	--	1	0.42	--	No
	Beryllium	42	--	42	0.7	--	No
OU2 (Groundwater) µg/L	2-Methylnaphthalene	--	--	150 (A)	13	--	No
	4-Methylphenol	--	--	180 (A)	6	--	No
	Chloroform	100	70	140 (A)	3	ND	No
	Trichlorofluoromethane	--	--	11,000 (A)	2	--	No
OU2 (Surface Water) µg/L	Lead	--	--	15 (A)	41	--	**Yes**
	Manganese	--	--	50 (B)	9,700	--	**Yes**
OU4 (Groundwater) µg/L	2-Methylnaphthalene	--	--	150 (A)	48.2	--	No
	4-Methylphenol (p-cresol)	--	--	180 (A)	40.6	--	No
	Acetone	3,650	--	3,300 (A)	112	ND (0.75)	No
	Chloroethane	--	--	290 (A)	1.9	--	No
	Chloromethane	--	--	66 (A)	8.94	--	No
	cis-1,3-Dichloropropene	--	--	8.5 (A)	0.0969	--	No

Table B-2
Evaluation of Changes for New, More Stringent, Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD Established RAO for COCs or Former Standard from Previous Review Period (2008)	Current Federal MCL	Current Alaska Cleanup Level	Maximum Detected at ROD	Maximum Detected During Most Recent Sampling Event	New Risk Evaluation Needed?
OU4 (Groundwater) µg/L *(Continued)*	Dieldrin	0.05	--	0.053 (A)	0.0335	--	No
	Methyl ethyl ketone	--	--	22,000 (A)	27.7	--	No
	Phenol	22,000	--	11,000 (A)	5.12	--	No
	Trichlorofluoromethane	--	--	11,000 (A)	0.379	--	No
OU4 (Soil) mg/kg	Xylenes, total	78	--	63	55.7	3.91	No
	1,1,1-Trichloroethane	1.0	--	0.82	2.9	--	**Yes**
	2-Methylnaphthalene	6.1	--	6.1	22.4	--	**Yes**
	4,4-DDD	35	--	7.2	0.0139	--	No
	4,4-DDE	24	--	5.1	0.00329	--	No
	4,4-DDT	24	--	7.3	0.0385	--	No
	4-Methylphenol	1.5	--	1.5	0.0197	--	No
	Acenaphthene	210	--	180	1.5	--	No
	Acetone	88	--	88	0.641	--	No
	Aldrin	0.5	--	0.070	0.00997	--	No
	Anthracene	4,300	--	3,000	0.641	--	No
	Benzo(a)anthracene	6	--	3.6	0.69	--	No
	Benzo(g,h,i)perylene	1,400	--	1,400	0.947	--	No
	Benzo(k)fluoranthene	110	--	49	4.92	--	No

Table B-2
Evaluation of Changes for New, More Stringent, Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD Established RAO for COCs or Former Standard from Previous Review Period (2008)	Current Federal MCL	Current Alaska Cleanup Level	Maximum Detected at ROD	Maximum Detected During Most Recent Sampling Event	New Risk Evaluation Needed?
OU4 (Soil) mg/kg *(Continued)*	bis(2-ethylhexyl) phthalate	590	--	13	5.59	--	No
	Butylbenzylphthalate	5,600	--	920	0.102	--	No
	Chromium	48.44	--	25	48.44	--	No[1]
	Chrysene	620	--	360	1.48	--	No
	Copper	460[b]	--	460	1,120	--	No[1]
	Dibenzofuran	11	--	11	1.2	--	No
	Di-n-butylphthalate	1,700	--	80	0.0508	--	No
	Endosulfan sulfate	64	--	64	0.00423	--	No
	Endrin	0.3	--	0.29	0.0148	--	No
	Fluoranthene	2,100	--	1,400	1.75	--	No
	Fluorene	270	--	220	1.35	--	No
	Methyl ethyl ketone	59	--	59	0.197	--	No
	Naphthalene	21	--	20	7.49	ND (0.0017)	No
	Nickel	51	--	1.4	50.68	--	No[1]
	Phenanthrene	3,000	--	3,000	3.82	--	No
	Pyrene	1,500	--	1,000	4.52	--	No

Table B-2
Evaluation of Changes for New, More Stringent, Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD Established RAO for COCs or Former Standard from Previous Review Period (2008)	Current Federal MCL	Current Alaska Cleanup Level	Maximum Detected at ROD	Maximum Detected During Most Recent Sampling Event	New Risk Evaluation Needed?
OU4 (Soil) mg/kg *(Continued)*	Thallium	--[b]	--	1.9	9.58	--	No[1]
	Tetrachloroethene (PCE)	0.3	--	0.024	0.00688	--	No
	Zinc	9,100	--	4,100	555	--	No
OU5 (Groundwater) µg/L	2-Methylnaphthalene	--	--	150 (A)	9	--	No
	Chlorethane	--	--	290 (A)	1.3	--	No
OU5 (Surface Water) µg/L	1,1-Dichloroethane	--	--	7.3 (B)	2.3	--	No
	4-Methylphenol	--	--	180 (A)	7	--	No
	1,1,2,2-Tetrachloroethane	110	1.7	--	4.3	ND (0.22)	No
	Bromomethane	--	--	51 (A)	13	--	No
OU5 (Soil) mg/kg	Xylenes, total	78	--	63	3.94	--	No
	Anthracene	4,300	--	3,000	0.063	--	No
	Benzo(a)anthracene	6	--	3.6	0.2	--	No
	Benzo(k)fluoranthene	110	--	49	0.18	--	No
	bis(2-ethylhexyl)phthalate	590	--	13	0.018	--	No
	Chromium	26	--	25	64	--	**Yes**
	Chrysene	620	--	360	0.24	--	No

Table B-2
Evaluation of Changes for New, More Stringent, Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD Established RAO for COCs or Former Standard from Previous Review Period (2008)	Current Federal MCL	Current Alaska Cleanup Level	Maximum Detected at ROD	Maximum Detected During Most Recent Sampling Event	New Risk Evaluation Needed?
OU5 (Soil) mg/kg *(Continued)*	Copper	460	--	460	38	--	No
	Diethyl phthalate	190	--	130	0.049	--	No
	Di-n-butyl phthalate	1,700	--	80	0.039	--	No
	Fluoranthene	2,100	--	1,400	0.3	--	No
	Indeno(1,2,3,-cd)pyrene	11	--	4.9	0.098	--	No
	Naphthalene	21	--	20	0.069	ND (0.0017)	No
	Pyrene	1,500	--	1,000	0.28	--	No
	Selenium	3.5	--	3.4	3.1	--	No
	Silver	21	--	11.2	22	--	**Yes**
	Thallium	--	--	1.9	0.59	--	No
	Zinc	9,100	--	4,100	159	--	No
OU6 (Groundwater) µg/L	Acenaphthylene	--	--	2200	7.23	--	No
	2-Butanone (MEK)	--	--	22,000 (A)	32.4	--	No
	2-Methylnaphthalene	--	--	150 (A)	630	--	**Yes**
	4-Methyl-2-pentanone (MIBK)	--	--	2,900 (A)	31.7	--	No
	4,4-DDD	3.6	--	3.5 (A)	0.0908	--	No
	Arsenic	50	10	10 (A)	74.8	--	No[1]
	Chloroethane	--	--	290 (A)	0.83	--	No

Table B-2
Evaluation of Changes for New, More Stringent, Standards (Continued)

Operable Unit (matrix and units)	**COPCs (Final ROD COCs in bold)**	**ROD Established RAO for COCs or Former Standard from Previous Review Period (2008)**	**Current Federal MCL**	**Current Alaska Cleanup Level**	**Maximum Detected at ROD**	**Maximum Detected During Most Recent Sampling Event**	**New Risk Evaluation Needed?**
OU6 (Groundwater) µg/L *(Continued)*							
	Chloromethane	--	--	66 (A)	4.33	--	No
	Copper	1,300	1,300	1,000 (A)	345	--	No
	Dimethylphthalate	--	--	370,000 (A)	110	--	No
	Di-n-octylphthalate	700	--	1,500 (A)	49.6	--	No
	Endosulfan I	--	--	220 (A)	0.0087	--	No
	Phenanthrene	--	--	11,000 (A)	1.3	--	No
	Phenol	22,000	--	11,000 (A)	88.3	--	No
	Zinc	11,000	--	5,000 (A)	401	--	No
OU6 (Surface Water) µg/L	Arsenic	20	--	10 (B)	0.0963	**--**	No
	Phenol	4,600,000	4,600,000	11,000 (B)	4.36	ND (11)	No
OU6 (Soil)[2] mg/kg	Benzene	0.02		0.025	11.9	**2.3**	**Yes**
	1,1,1-Trichloroethane	1.0	**--**	0.82	9.2	ND (0.0449)	No
	1,2,4-Trichlorobenzene	2	--	0.85	0.108	**--**	No
	1,2-Dichlorobenzene	7	**--**	5.1	18.5 (deep) 307 (surface)	NS ND (0.0449)	**Yes** No
	1,3-Dichlorobenzene	--	--	28	5.11 (deep) 165 (surface)	NS ND (0.0449)	No No

Table B-2
Evaluation of Changes for New, More Stringent, Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD Established RAO for COCs or Former Standard from Previous Review Period (2008)	Current Federal MCL	Current Alaska Cleanup Level	Maximum Detected at ROD	Maximum Detected During Most Recent Sampling Event	New Risk Evaluation Needed?
OU6 (Soil)[2] mg/kg *(Continued)*	1,4-Dichlorobenzene	0.8	--	0.64	15.5 (deep) 147 (surface)	NS ND (0.0449)	**Yes** No
	2-Butanone(MEK)	--	--	59	0.0721	--	No
	2-Methylnaphthalene	--	--	6.1	9.87	0.087	No
	4-Methyl-2-pentanone (MIBK)	--	--	8.1	0.0223	--	No
	4,4-DDD	35	--	7.2	8.41	0.207	No
	4,4-DDE	24	--	5.1	1.69	0.361	No
	4,4-DDT	24	--	7.3	47.3	0.331	No
	Aldrin	0.5	--	0.070	0.0222	ND (0.00909)	No
	Anthracene	4,300	--	3,000	0.0719	--	No
	Arsenic	9.31[a]	--	3.9	13.27	--	No[1]
	Benzo(a)anthracene	6	--	3.6	0.23	0.183	No
	Benzo(b)fluoranthene	11	--	4.9	0.466	0.0152	No
	Benzo(g,h,i)perylene	1,400	--	1,400	0.24	--	No
	Benzo(k)fluoranthene	110	--	49	0.466	0.0236	No
	bis(2-ethylhexyl)phthalate	590	--	13	53.7	--	**Yes**
	Butyl benzyl phthalate	5,600	--	920	0.0335	--	No

Table B-2
Evaluation of Changes for New, More Stringent, Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD Established RAO for COCs or Former Standard from Previous Review Period (2008)	Current Federal MCL	Current Alaska Cleanup Level	Maximum Detected at ROD	Maximum Detected During Most Recent Sampling Event	New Risk Evaluation Needed?
OU6 (Soil)[2] mg/kg *(Continued)*	Chromium	48.44[a]	--	25	76.94	--	No[1]
	Chrysene	620	--	360	0.595	0.0207	No
	Copper	460[b]	--	460	1,170	--	No[1]
	Dibenzofuran	--	--	11	0.0894	--	No
	Dieldrin	0.015	--	0.0076	0.143	ND (0.0121)	No
	Diethyl phthalate	190	--	130	0.183	--	No
	Dimethyl phthalate	1,400	--	1,100	0.0655	--	No
	Di-n-butyl phthalate	1,700	--	80	0.325	--	No
	Endrin	0.3	--	0.29	0.0226	ND (0.0121)	No
	Fluoranthene	2,100	--	1,400	0.762	--	No
	Fluorene	270	--	220	0.0323	--	No
	Heptachlor	0.8	--	0.28	0.00844	ND (0.0121)	No
	Heptachlor epoxide	0.2	--	0.014	0.023	ND (0.0121)	No
	Indeno(1,2,3,-cd)pyrene	11	--	4.9	0.102	--	No
	Naphthalene	21	--	20	2.47	--	No
	Pyrene	1,500	--	1,000	0.516	--	No

Table B-2
Evaluation of Changes for New, More Stringent, Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	ROD Established RAO for COCs or Former Standard from Previous Review Period (2008)	Current Federal MCL	Current Alaska Cleanup Level	Maximum Detected at ROD	Maximum Detected During Most Recent Sampling Event	New Risk Evaluation Needed?
OU6 (Soil)[2] mg/kg *(Continued)*	Styrene	1.3	--	0.96	0.0146	**--**	No
	Tetrachloroethene (PCE)	0.03	**--**	0.024	0.0666	**--**	**Yes**
	Thallium	--	**--**	1.9	12	**--**	**Yes**
DP098 (Groundwater) µg/L	Chloromethane	--	--	66	10	**--**	No

Notes:
[1] The maximum detection of the analyte at the time of the ROD is within the normal background range for JBER-E therefore, the cleanup level is still protective and no further evaluation is needed.
[2] Updated soil cleanup levels have been evaluated for all soil contaminant detections for all OU6 sites. However, soil COC cleanup levels in the OU6 ROD are applicable to SD015 only, except for lead at LF002. The OU6 ROD did not specify soil COCs for the other sites that comprise OU6.
[a] ROD-specified limit based on elevated background concentrations.
[b] The analyte was identified in the ROD as a COPC; however, no cleanup level was assigned. Therefore, the cleanup level from the 2008 five-year review period was utilized to identify any changes in MCLs from the previous review period.

Table B-3
Risk/Hazard Estimates for Chemicals above New Standards

Operable Unit (matrix and units)	COPCs (Final ROD COCs in Bold)	Current Standard	Applicable Site Concentration	Oral Reference Dose (RfDo) (mg/kg-d)	Oral Slope Factor (SFo) $(mg/kg\text{-}d)^{-1}$	Hazard Quotient (≥ 1 listed in Bold)	Cancer Risk	Pathway Utilized for Risk Calculation
Groundwater μg/L								
OU1	Fluoride	4,000	5,200	0.06	No toxicity value	**2.37**	--	--
	Nickel	100	310	0.02	No toxicity value	0.42	--	--
OU6	2-Methylnaphthalene	150	630	0.004	No toxicity value	**4.32**	--	--
Surface Water μg/L								
OU2	**Manganese**	50	9700	0.14	no toxicity value	**1.90**	--	--
	Lead	15	41	No toxicity value	no toxicity value	NA	--	--

Table B-3
Risk/Hazard Estimates for Chemicals above New Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in Bold)	Current Standard	Applicable Site Concentration	Oral Reference Dose (RfDo) (mg/kg-d)	Oral Slope Factor (SFo) $(mg/kg\text{-}d)^{-1}$	Hazard Quotient (≥ 1 listed in Bold)	Cancer Risk	Pathway Utilized for Risk Calculation
Soil mg/kg								
OU1	bis(2-ethylhexyl) phthalate	13	13	0.02	0.014	0.02	5.85E-07	Direct Contact
	Antimony	3.6	14.6	0.0004	No toxicity value	0.36	--	Direct Contact
	Arsenic	3.9	30.9	0.0003	1.5	**1.22**	6.88E-05	Direct Contact
	Barium	1,100	2,110	0.2	No toxicity value	0.10	--	Direct Contact
	Cadmium	5	20.6	0.0005	No toxicity value	0.26	--	Direct Contact
OU4	1,1,1-Trichloroethane	0.82	2.9	2 [b]	No toxicity value	0.0006	--	Inhalation
	2-Methylnaphthalene	6.1	22.4	0.004	No toxicity value	0.08	--	Direct Contact
OU5	Chromium	25	64	1.5	No toxicity value	0.21	--	Direct Contact
	Silver	11.2	22	0.005	No toxicity value	0.04	--	Direct Contact

Table B-3
Risk/Hazard Estimates for Chemicals above New Standards (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in Bold)	Current Standard	Applicable Site Concentration	Oral Reference Dose (RfDo) (mg/kg-d)	Oral Slope Factor (SFo) $(mg/kg\text{-}d)^{-1}$	Hazard Quotient (≥ 1 listed in Bold)	Cancer Risk	Pathway Utilized for Risk Calculation
OU6	**Benzene**	0.025	2.3	0.004	0.055	0.0202	2.02E-06	Inhalation
	1,2-Dichlorobenzene	5.1	18.5	0.09	no toxicity value	0.0094	--	Inhalation
	1,4-Dichlorobenzene	0.64	15.5	No toxicity value	0.024[a]	0.0022	5.22E-06	Inhalation
	bis(2-ethylhexyl)phthalate	13	53.7	0.02	0.014	0.07	2.42E-06	Direct Contact
	Tetrachloroethene (PCE)	0.024	0.0666	0.006[b]	0.0021[b]	0.00004	6.77E-08	Inhalation
	Thallium	1.9	12	0.00008[a]	No toxicity value	**1.48**	--	Direct Contact

Notes:
Exposure parameters were taken from ADEC Cleanup Level Guidance June 9, 2008
Oral Reference Dose (RfDo) and Oral Slope Factor (SFo) are those published on the Environmental Protection Agency's Integrated Risk Information System (IRIS), except as noted. IRIS was accessed in October 2013 for use in this report.
[a] The ADEC-published value was used because none was available via IRIS.
[b] Value has been updated since the publication of ADEC cleanup level guidance or since 2007.

Table B-4
Risks and Hazards for COPCs with Toxicity Changes

Chemical	Cleanup Level	Ingestion Intake Factor Noncancer (mg/kg-d)	Ingestion Intake Factor Cancer (mg/kg-d)	Oral Reference Dose (RfD_0) (mg/kg-d)	Oral Slope Factor (SF_0) (mg/kg-d)	Hazard Quotient (HQ)	Cancer Risk (CR)	Is Cleanup Level Sufficiently Protective?
Groundwater μg/L								
Carbon tetrachloride	5	1.37E-04	5.87E-05	0.004	0.07	0.03	4.1E-06	Yes
1,2-Dichloroethane	5	1.37E-04	5.87E-05	0.006[a]	0.091	0.02	5.3E-06	Yes
1,1-Dichloroethene	7	1.92E-04	8.22E-05	0.05[b]	No toxicity value	0.004	Not applicable	Yes
cis-1,2-Dichloroethene	70	1.92E-03	8.22E-04	0.002	No toxicity value	0.96	Not applicable	Yes
trans-1,2-Dichloroethene	100	2.74E-03	1.17E-03	0.02	No toxicity value	0.14	Not applicable	Yes
2-Hexanone	14.4[c]	3.95E-04	1.69E-04	0.005	No toxicity value	0.08	Not applicable	NA
Methylene Chloride	5	1.37E-04	5.87E-05	0.006	0.002	0.02	1.2E-07	Yes
1,1,2,2-Tetrachloroethane	4	1.10E-04	4.70E-05	0.02	0.2	0.01	9.4E-06	Yes
Tetrachloroethene	5	1.37E-04	5.87E-05	0.006	0.0021	0.02	1.2E-07	Yes
Toluene	1,000	2.74E-02	1.17E-02	0.08[b]	No toxicity value	0.34	Not applicable	Yes
1,1,1-Trichloroethane	200	5.48E-03	2.35E-03	2	No toxicity value	0.003	Not applicable	Yes
Trichloroethene	5	1.37E-04	5.87E-05	0.0005	0.046	0.27	2.7E-06	Yes

Table B-4
Risks and Hazards for COPCs with Toxicity Changes (Continued)

Chemical	Cleanup Level	Ingestion Intake Factor Noncancer (mg/kg-d)	Ingestion Intake Factor Cancer (mg/kg-d)	Oral Reference Dose (RfD_0) (mg/kg-d)	Oral Slope Factor (SF_0) (mg/kg-d)	Hazard Quotient (HQ)	Cancer Risk (CR)	Is Cleanup Level Sufficiently Protective?
Soil mg/kg								
Cyanide[d]	27	2.66E-04	Not applicable	0.0006	No toxicity value	0.44	Not applicable	Yes

Notes: ***(Notes continue on next page)***

Exposure parameters were taken from ADEC Cleanup Levels Guidance June 9, 2008.

Oral Reference Dose (RfDo) and Oral Slope Factor (SFo) are those published on the Environmental Protection Agency's Integrated Risk Information System (IRIS), except as noted. IRIS was accessed in October 2013 for this report.

[a] Value found in Provisional Peer Reviewed Toxicity Values (PPRTV) appendix, updated 10/1/2010, accessed in May 2013 here: http://hhpprtv.ornl.gov/

[b] Toxicity values differ from those reported in previous review period, although no changes to values are reported in IRIS database.

[c] No cleanup level exists so the maximum site concentration was used to calculate potential risk.

[d] Cyanide was evaluated at the most stringent cleanup level (migration to groundwater) using updated toxicity information from IRIS. The maximum concentration of this contaminant in OU4 soil at the time of the ROD was 3.6 mg/kg, which is less than the cleanup level and still protective of human health. The direct contact cleanup level of 2000 mg/kg would result in a hazard quotient of 32 and would not be protective of human health at this site.

Table B-4
Risks and Hazards for COPCs with Toxicity Changes (Continued)

Parameter for Groundwater Calculations	Unit	Value
Ingestion rate of water (IR)	L/day	2
Exposure frequency (EF)	days/yr	350
Exposure duration (ED)	yrs	30
Absorption factor (A)	()	1
Body Weight (BW)	kg	70
Conversion factor (CF1)	ug/mg	1000
Averaging time (noncancer) (ATnc)	year	30
Averaging time (cancer) (ATc)	year	70
Intake factor - cancer (IFc) (IR*EF*ED*A)/(BW*CF1*365 days/yr*ATc)	(L-mg)/(kg-d-ug)	1.17417E-05
Intake factor - non-cancer (IFnc) (IR*EF*ED*A)/(BW*CF1*365 days/yr*ATnc)	(L-mg)/(kg-d-ug)	2.73973E-05

Notes:
Hazard Quotient = concentration *IFnc / RfDo
Cancer Risk = concentration* IFc *Sfo

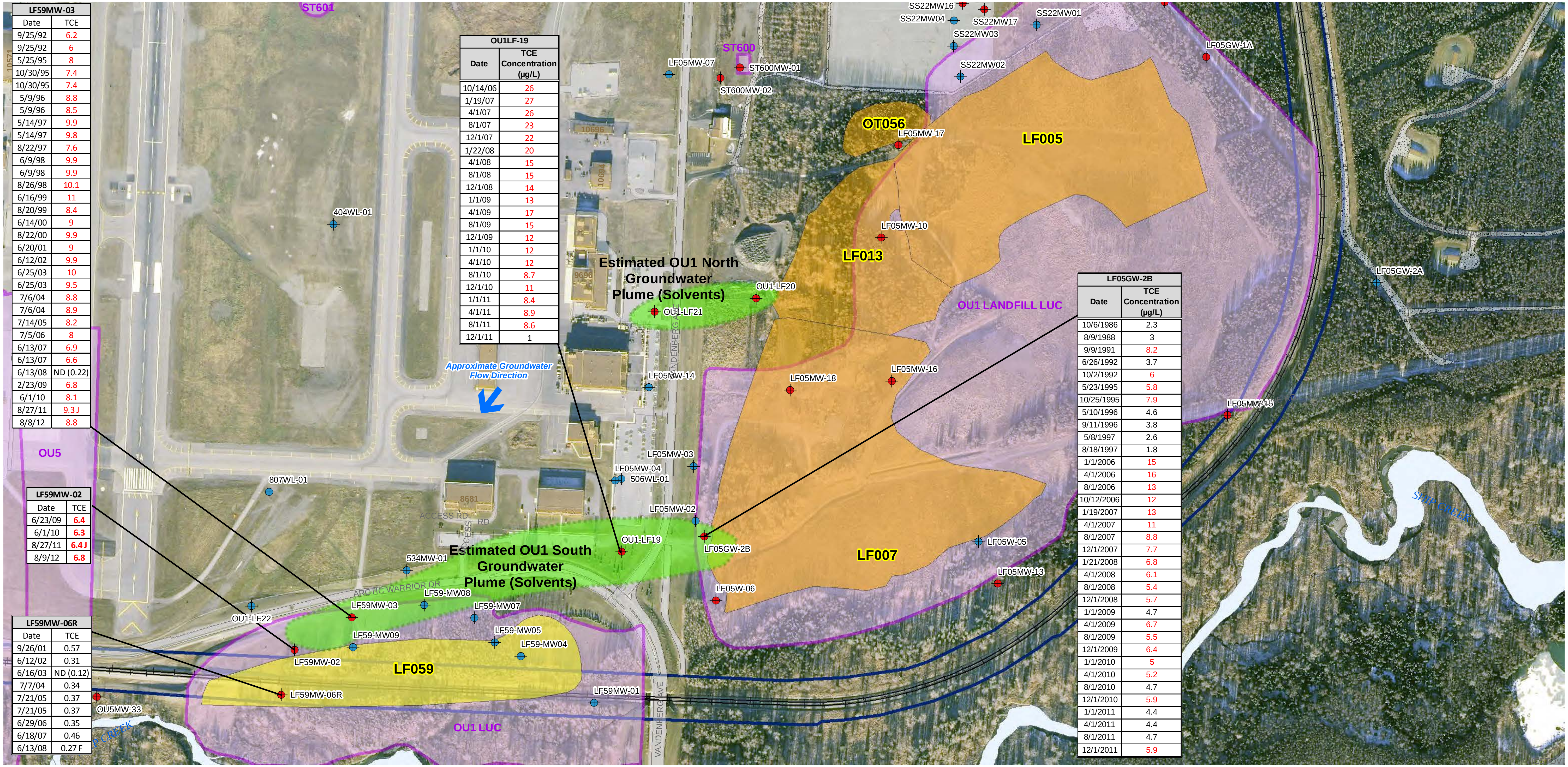
Table B-4
Risks and Hazards for COPCs with Toxicity Changes (Continued)

Parameter for Soil Calculations	Unit	Value
Ingestion rate of soil (IR)	mg/day	200
Exposure frequency (EF)	days/yr	270
Exposure duration (ED)	yrs	6
Body Weight (BW)	kg	15
Conversion factor (CF2)	kg/mg	0.000001
Averaging time (noncancer) (ATnc)	year	6
Equation 3 Direct Contact Intake factor - non-cancer (IFnc) (EF*ED*IR*CF2)/(BW*365 days/yr*ATnc)	kg/kg-d	9.863E-06

Notes:
Hazard Quotient = concentration *IFnc / RfDo

APPENDIX C

Monitoring Figures



LF59MW-03	
Date	TCE
9/25/92	6.2
9/25/92	6
5/25/95	8
10/30/95	7.4
10/30/95	7.4
5/9/96	8.8
5/9/96	8.5
5/14/97	9.9
5/14/97	9.8
8/22/97	7.6
6/9/98	9.9
6/9/98	9.9
8/26/98	10.1
6/16/99	11
8/20/99	8.4
6/14/00	9
8/22/00	9.9
6/20/01	9
6/12/02	9.9
6/25/03	10
6/25/03	9.5
7/6/04	8.8
7/6/04	8.9
7/14/05	8.2
7/5/06	8
6/13/07	6.9
6/13/07	6.6
6/13/08	ND (0.22)
2/23/09	6.8
6/1/10	8.1
8/27/11	9.3 J
8/8/12	8.8

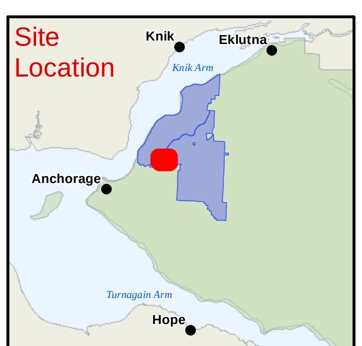
OU1LF-19	
Date	TCE Concentration (µg/L)
10/14/06	26
1/19/07	27
4/1/07	26
8/1/07	23
12/1/07	22
1/22/08	20
4/1/08	15
8/1/08	15
12/1/08	14
1/1/09	13
4/1/09	17
8/1/09	15
12/1/09	12
1/1/10	12
4/1/10	12
8/1/10	8.7
12/1/10	11
1/1/11	8.4
4/1/11	8.9
8/1/11	8.6
12/1/11	1

LF59MW-02	
Date	TCE
6/23/09	6.4
6/1/10	6.3
8/27/11	6.4 J
8/9/12	6.8

LF59MW-06R	
Date	TCE
9/26/01	0.57
6/12/02	0.31
6/16/03	ND (0.12)
7/7/04	0.34
7/21/05	0.37
7/21/05	0.37
6/29/06	0.35
6/18/07	0.46
6/13/08	0.27 F

LF05GW-2B	
Date	TCE Concentration (µg/L)
10/6/1986	2.3
8/9/1988	3
9/9/1991	8.2
6/26/1992	3.7
10/2/1992	6
5/23/1995	5.8
10/25/1995	7.9
5/10/1996	4.6
9/11/1996	3.8
5/8/1997	2.6
8/18/1997	1.8
1/1/2006	15
4/1/2006	16
8/1/2006	13
10/12/2006	12
1/19/2007	13
4/1/2007	11
8/1/2007	8.8
12/1/2007	7.7
1/21/2008	6.8
4/1/2008	6.1
8/1/2008	5.4
12/1/2008	5.7
1/1/2009	4.7
4/1/2009	6.7
8/1/2009	5.5
12/1/2009	6.4
1/1/2010	5
4/1/2010	5.2
8/1/2010	4.7
12/1/2010	5.9
1/1/2011	4.4
4/1/2011	4.4
8/1/2011	4.7
12/1/2011	5.9

Site Location



- Non-Program Monitoring Well
- Program Monitoring Well
- Inferred Groundwater Plume (Solvents)
- Closed CERCLA Site
- Open CERCLA Site
- Land Use Control Boundary
- JBER Boundary

Notes:
1. All groundwater results are in micrograms/liter [µ/L].
2. Red results exceed cleanup criteria.
TCE = Trichloroethylene
Cleanup Criteria = [5 µ/L]
ND = Not Detected (Detection Limit)
FLAGS:
F - Result in between the method detection limit and the reporting limit.
J - Analyte was positively identified, but result is

Digital Orthomosaic of Elmendorf & Richardson military installations based on September-October 2012 aerial photography with a pixel ground resolution of 1m. Aero-Metric, Anchorage

N

All Locations Are Approximate

0 250 500 750 1,000
Feet

WGS 1984 UTM Zone 6N

LF059 SITE MAP
WITH HISTORICAL DATA

JOINT BASE ELMENDORF-RICHARDSON, ALASKA

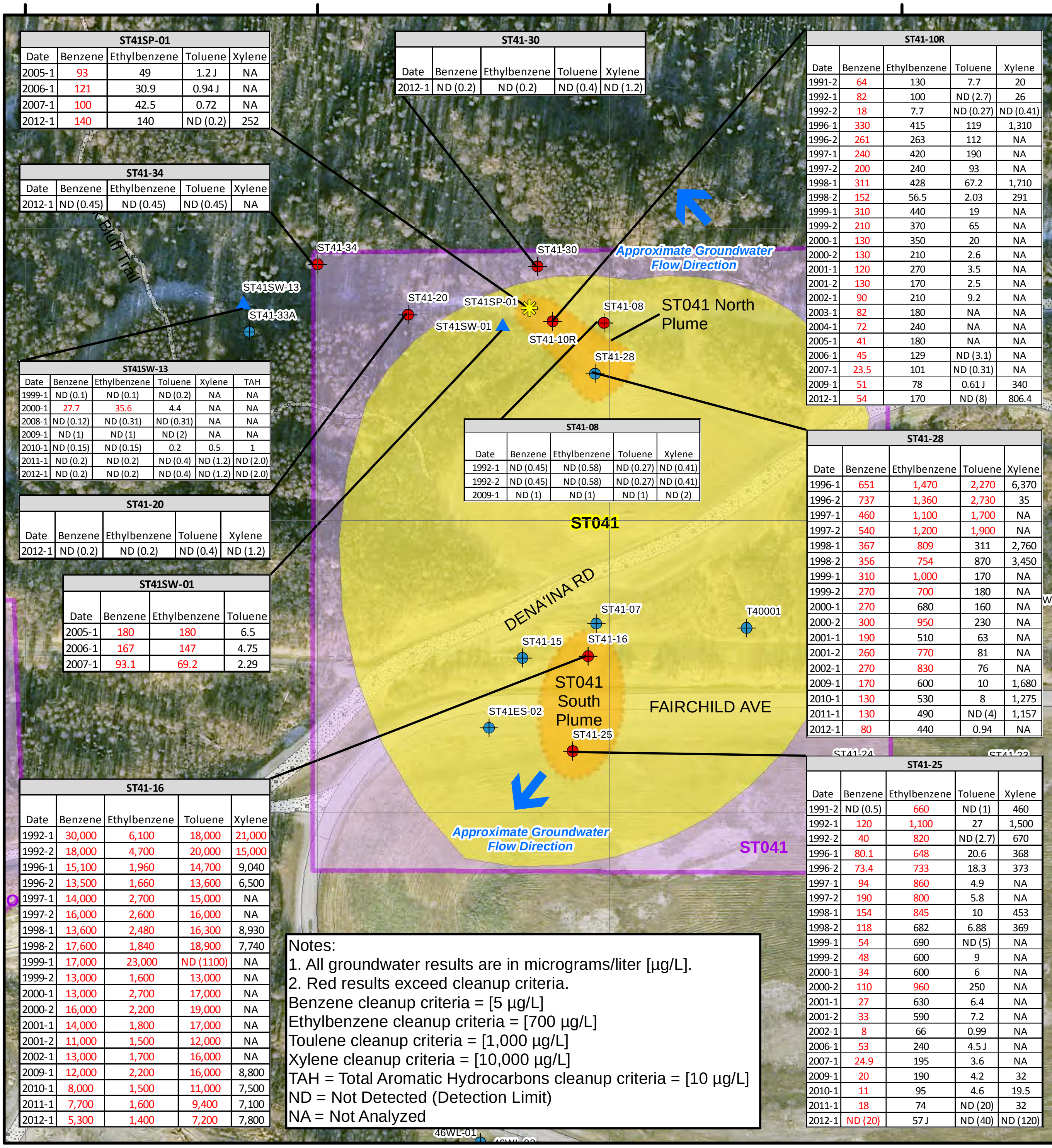
JACOBS

DATE: 11 MAR 2014

PROJECT MANAGER: K. MAHER

FIGURE NO: C-1

P:\JBER\AFCEE-08\TO142_FiveYearReview\MXD\Elmendorf5Yr_2013\LF59_SiteMapAndWells.mxd beatycj



ST41SP-01				
Date	Benzene	Ethylbenzene	Toluene	Xylene
2005-1	93	49	1.2 J	NA
2006-1	121	30.9	0.94 J	NA
2007-1	100	42.5	0.72	NA
2012-1	140	140	ND (0.2)	252

ST41-30				
Date	Benzene	Ethylbenzene	Toluene	Xylene
2012-1	ND (0.2)	ND (0.2)	ND (0.4)	ND (1.2)

ST41-10R				
Date	Benzene	Ethylbenzene	Toluene	Xylene
1991-2	64	130	7.7	20
1992-1	82	100	ND (2.7)	26
1992-2	18	7.7	ND (0.27)	ND (0.41)
1996-1	330	415	119	1,310
1996-2	261	263	112	NA
1997-1	240	420	190	NA
1997-2	200	240	93	NA
1998-1	311	428	67.2	1,710
1998-2	152	56.5	2.03	291
1999-1	310	440	19	NA
1999-2	210	370	65	NA
2000-1	130	350	20	NA
2000-2	130	210	2.6	NA
2001-1	120	270	3.5	NA
2001-2	130	170	2.5	NA
2002-1	90	210	9.2	NA
2003-1	82	180	NA	NA
2004-1	72	240	NA	NA
2005-1	41	180	NA	NA
2006-1	45	129	ND (3.1)	NA
2007-1	23.5	101	ND (0.31)	NA
2009-1	51	78	0.61 J	340
2012-1	54	170	ND (8)	806.4

ST41-34				
Date	Benzene	Ethylbenzene	Toluene	Xylene
2012-1	ND (0.45)	ND (0.45)	ND (0.45)	NA

ST41SW-13					
Date	Benzene	Ethylbenzene	Toluene	Xylene	TAH
1999-1	ND (0.1)	ND (0.1)	ND (0.2)	NA	NA
2000-1	27.7	35.6	4.4	NA	NA
2008-1	ND (0.12)	ND (0.31)	ND (0.31)	NA	NA
2009-1	ND (1)	ND (1)	ND (2)	NA	NA
2010-1	ND (0.15)	ND (0.15)	0.2	0.5	1
2011-1	ND (0.2)	ND (0.2)	ND (0.4)	ND (1.2)	ND (2.0)
2012-1	ND (0.2)	ND (0.2)	ND (0.4)	ND (1.2)	ND (2.0)

ST41-08				
Date	Benzene	Ethylbenzene	Toluene	Xylene
1992-1	ND (0.45)	ND (0.58)	ND (0.27)	ND (0.41)
1992-2	ND (0.45)	ND (0.58)	ND (0.27)	ND (0.41)
2009-1	ND (1)	ND (1)	ND (1)	ND (2)

ST41-20				
Date	Benzene	Ethylbenzene	Toluene	Xylene
2012-1	ND (0.2)	ND (0.2)	ND (0.4)	ND (1.2)

ST41SW-01			
Date	Benzene	Ethylbenzene	Toluene
2005-1	180	180	6.5
2006-1	167	147	4.75
2007-1	93.1	69.2	2.29

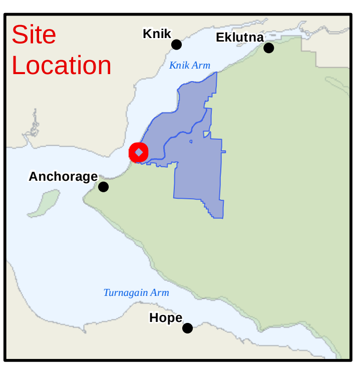
ST41-28				
Date	Benzene	Ethylbenzene	Toluene	Xylene
1996-1	651	1,470	2,270	6,370
1996-2	737	1,360	2,730	35
1997-1	460	1,100	1,700	NA
1997-2	540	1,200	1,900	NA
1998-1	367	809	311	2,760
1998-2	356	754	870	3,450
1999-1	310	1,000	170	NA
1999-2	270	700	180	NA
2000-1	270	680	160	NA
2000-2	300	950	230	NA
2001-1	190	510	63	NA
2001-2	260	770	81	NA
2002-1	270	830	76	NA
2009-1	170	600	10	1,680
2010-1	130	530	8	1,275
2011-1	130	490	ND (4)	1,157
2012-1	80	440	0.94	NA

ST41-16				
Date	Benzene	Ethylbenzene	Toluene	Xylene
1992-1	30,000	6,100	18,000	21,000
1992-2	18,000	4,700	20,000	15,000
1996-1	15,100	1,960	14,700	9,040
1996-2	13,500	1,660	13,600	6,500
1997-1	14,000	2,700	15,000	NA
1997-2	16,000	2,600	16,000	NA
1998-1	13,600	2,480	16,300	8,930
1998-2	17,600	1,840	18,900	7,740
1999-1	17,000	23,000	ND (1100)	NA
1999-2	13,000	1,600	13,000	NA
2000-1	13,000	2,700	17,000	NA
2000-2	16,000	2,200	19,000	NA
2001-1	14,000	1,800	17,000	NA
2001-2	11,000	1,500	12,000	NA
2002-1	13,000	1,700	16,000	NA
2009-1	12,000	2,200	16,000	8,800
2010-1	8,000	1,500	11,000	7,500
2011-1	7,700	1,600	9,400	7,100
2012-1	5,300	1,400	7,200	7,800

ST41-25				
Date	Benzene	Ethylbenzene	Toluene	Xylene
1991-2	ND (0.5)	660	ND (1)	460
1992-1	120	1,100	27	1,500
1992-2	40	820	ND (2.7)	670
1996-1	80.1	648	20.6	368
1996-2	73.4	733	18.3	373
1997-1	94	860	4.9	NA
1997-2	190	800	5.8	NA
1998-1	154	845	10	453
1998-2	118	682	6.88	369
1999-1	54	690	ND (5)	NA
1999-2	48	600	9	NA
2000-1	34	600	6	NA
2000-2	110	960	250	NA
2001-1	27	630	6.4	NA
2001-2	33	590	7.2	NA
2002-1	8	66	0.99	NA
2006-1	53	240	4.5 J	NA
2007-1	24.9	195	3.6	NA
2009-1	20	190	4.2	32
2010-1	11	95	4.6	19.5
2011-1	18	74	ND (20)	32
2012-1	ND (20)	57 J	ND (40)	ND (120)

Notes:
1. All groundwater results are in micrograms/liter [µg/L].
2. Red results exceed cleanup criteria.
Benzene cleanup criteria = [5 µg/L]
Ethylbenzene cleanup criteria = [700 µg/L]
Toulene cleanup criteria = [1,000 µg/L]
Xylene cleanup criteria = [10,000 µg/L]
TAH = Total Aromatic Hydrocarbons cleanup criteria = [10 µg/L]
ND = Not Detected (Detection Limit)
NA = Not Analyzed

Image Source: Aero-Metric, 2012

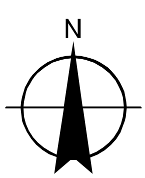


Seep Sample Location
Surface Water Sample Location
Program Monitoring Well
Non-Program Monitoring Well
Inferred Plume Boundary (Fuels)
CERCLA Site Boundary
Land Use Control Boundary

All Locations Are Approximate

0 150 300 450 600
Feet

WGS 1984 UTM Zone 6N



ST041 SITE MAP WITH HISTORICAL DATA

JOINT BASE ELMENDORF-RICHARDSON, ALASKA

JACOBS	DATE: 05 MAR 2014	PROJECT MANAGER: K. MAHER	FIGURE NO: C-2

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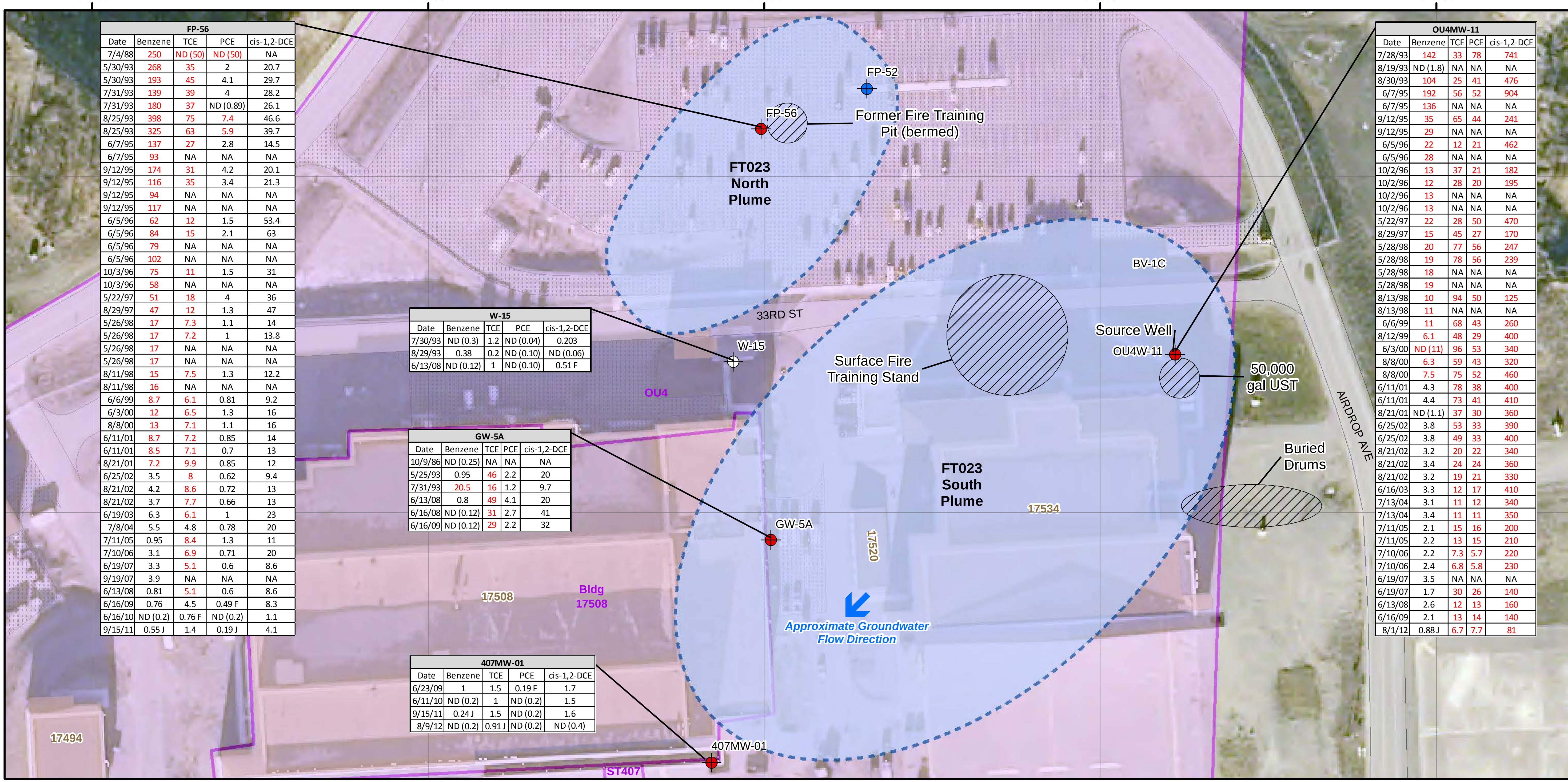


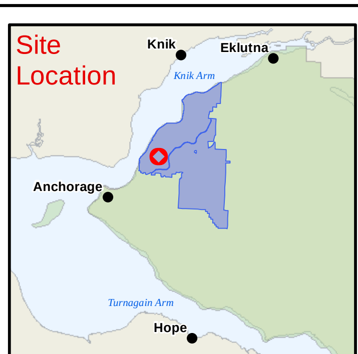
FP-56				
Date	Benzene	TCE	PCE	cis-1,2-DCE
7/4/88	250	ND (50)	ND (50)	NA
5/30/93	268	35	2	20.7
5/30/93	193	45	4.1	29.7
7/31/93	139	39	4	28.2
7/31/93	180	37	ND (0.89)	26.1
8/25/93	398	75	7.4	46.6
8/25/93	325	63	5.9	39.7
6/7/95	137	27	2.8	14.5
6/7/95	93	NA	NA	NA
9/12/95	174	31	4.2	20.1
9/12/95	116	35	3.4	21.3
9/12/95	94	NA	NA	NA
9/12/95	117	NA	NA	NA
6/5/96	62	12	1.5	53.4
6/5/96	84	15	2.1	63
6/5/96	79	NA	NA	NA
6/5/96	102	NA	NA	NA
10/3/96	75	11	1.5	31
10/3/96	58	NA	NA	NA
5/22/97	51	18	4	36
8/29/97	47	12	1.3	47
5/26/98	17	7.3	1.1	14
5/26/98	17	7.2	1	13.8
5/26/98	17	NA	NA	NA
5/26/98	17	NA	NA	NA
8/11/98	15	7.5	1.3	12.2
8/11/98	16	NA	NA	NA
6/6/99	8.7	6.1	0.81	9.2
6/3/00	12	6.5	1.3	16
8/8/00	13	7.1	1.1	16
6/11/01	8.7	7.2	0.85	14
6/11/01	8.5	7.1	0.7	13
8/21/01	7.2	9.9	0.85	12
6/25/02	3.5	8	0.62	9.4
8/21/02	4.2	8.6	0.72	13
8/21/02	3.7	7.7	0.66	13
6/19/03	6.3	6.1	1	23
7/8/04	5.5	4.8	0.78	20
7/11/05	0.95	8.4	1.3	11
7/10/06	3.1	6.9	0.71	20
6/19/07	3.3	5.1	0.6	8.6
9/19/07	3.9	NA	NA	NA
6/13/08	0.81	5.1	0.6	8.6
6/16/09	0.76	4.5	0.49 F	8.3
6/16/10	ND (0.2)	0.76 F	ND (0.2)	1.1
9/15/11	0.55 J	1.4	0.19 J	4.1

W-15				
Date	Benzene	TCE	PCE	cis-1,2-DCE
7/30/93	ND (0.3)	1.2	ND (0.04)	0.203
8/29/93	0.38	0.2	ND (0.10)	ND (0.06)
6/13/08	ND (0.12)	1	ND (0.10)	0.51 F

GW-5A				
Date	Benzene	TCE	PCE	cis-1,2-DCE
10/9/86	ND (0.25)	NA	NA	NA
5/25/93	0.95	46	2.2	20
7/31/93	20.5	16	1.2	9.7
6/13/08	0.8	49	4.1	20
6/16/08	ND (0.12)	31	2.7	41
6/16/09	ND (0.12)	29	2.2	32

407MW-01				
Date	Benzene	TCE	PCE	cis-1,2-DCE
6/23/09	1	1.5	0.19 F	1.7
6/11/10	ND (0.2)	1	ND (0.2)	1.5
9/15/11	0.24 J	1.5	ND (0.2)	1.6
8/9/12	ND (0.2)	0.91 J	ND (0.2)	ND (0.4)

OU4MW-11				
Date	Benzene	TCE	PCE	cis-1,2-DCE
7/28/93	142	33	78	741
8/19/93	ND (1.8)	NA	NA	NA
8/30/93	104	25	41	476
6/7/95	192	56	52	904
6/7/95	136	NA	NA	NA
9/12/95	35	65	44	241
9/12/95	29	NA	NA	NA
6/5/96	22	12	21	462
6/5/96	28	NA	NA	NA
10/2/96	13	37	21	182
10/2/96	12	28	20	195
10/2/96	13	NA	NA	NA
10/2/96	13	NA	NA	NA
5/22/97	22	28	50	470
8/29/97	15	45	27	170
5/28/98	20	77	56	247
5/28/98	19	78	56	239
5/28/98	18	NA	NA	NA
5/28/98	19	NA	NA	NA
8/13/98	10	94	50	125
8/13/98	11	NA	NA	NA
6/6/99	11	68	43	260
8/12/99	6.1	48	29	400
6/3/00	ND (11)	96	53	340
8/8/00	6.3	59	43	320
8/8/00	7.5	75	52	460
6/11/01	4.3	78	38	400
6/11/01	4.4	73	41	410
8/21/01	ND (1.1)	37	30	360
6/25/02	3.8	53	33	390
6/25/02	3.8	49	33	400
8/21/02	3.2	20	22	340
8/21/02	3.4	24	24	360
8/21/02	3.2	19	21	330
6/16/03	3.3	12	17	410
7/13/04	3.1	11	12	340
7/13/04	3.4	11	11	350
7/11/05	2.1	15	16	200
7/11/05	2.2	13	15	210
7/10/06	2.2	7.3	5.7	220
7/10/06	2.4	6.8	5.8	230
6/19/07	3.5	NA	NA	NA
6/19/07	1.7	30	26	140
6/13/08	2.6	12	13	160
6/16/09	2.1	13	14	140
8/1/12	0.88 J	6.7	7.7	81



Program Monitoring Well
Non-Program Monitoring Well
Abandoned Monitoring Well
Source Area (Approximate)
Land Use Control Boundary
Inferred Groundwater Plume (Fuels & Solvents)
Building
Paved Road
Unpaved Road
Parking Area

Notes:
1. All groundwater results are in micrograms/liter [µg/L].
2. Red results exceed cleanup criteria.
Benzene cleanup criteria = [5 µg/L]
TCE (Trichloroethene) cleanup criteria = [5 µg/L]
PCE (Tetrachloroethene) cleanup criteria = [5 µg/L]
cis-1,2 Dichloroethene cleanup criteria = [70 µg/L]
ND = Not Detected (Detection Limit)
NA = Not Analyzed

Flags:
F - Result between the method detection limit and the reporting limit.
J - Analyte was positively identified, but result is estimated.

N

All Locations Are Approximate
0 50 100 150 200
Feet
WGS 1984 UTM Zone 6N

FT023 SITE MAP
WITH HISTORICAL DATA

JOINT BASE ELMENDORF-RICHARDSON, ALASKA

JACOBS | DATE: 05 MAR 2014 | PROJECT MANAGER: K. MAHER | FIGURE NO: C-3

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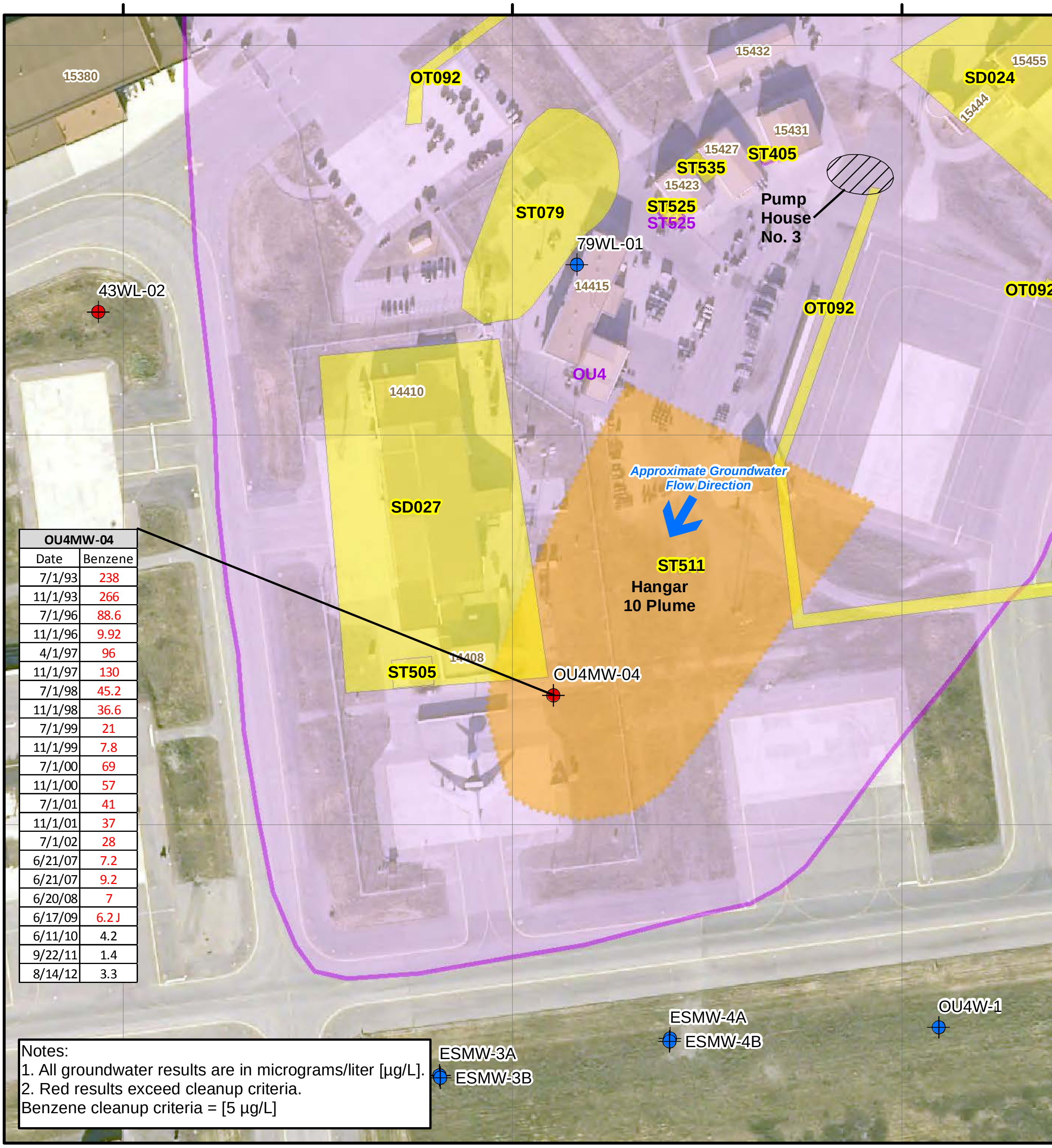
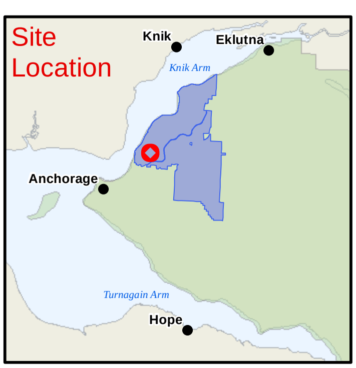


OU4MW-04	
Date	Benzene
7/1/93	238
11/1/93	266
7/1/96	88.6
11/1/96	9.92
4/1/97	96
11/1/97	130
7/1/98	45.2
11/1/98	36.6
7/1/99	21
11/1/99	7.8
7/1/00	69
11/1/00	57
7/1/01	41
11/1/01	37
7/1/02	28
6/21/07	7.2
6/21/07	9.2
6/20/08	7
6/17/09	6.2 J
6/11/10	4.2
9/22/11	1.4
8/14/12	3.3

Notes:
1. All groundwater results are in micrograms/liter [µg/L].
2. Red results exceed cleanup criteria.
Benzene cleanup criteria = [5 µg/L]

Image Source: Aero-Metric, 2012

Site Location



Program Monitoring Well
Non-Program Monitoring Well
Source Area (Approximate)
Inferred Plume Boundary (Fuels)
CERCLA Site Boundary
Land Use Control Boundary
Building

All Locations Are Approximate
0 100 200 300 400
Feet
WGS 1984 UTM Zone 6N

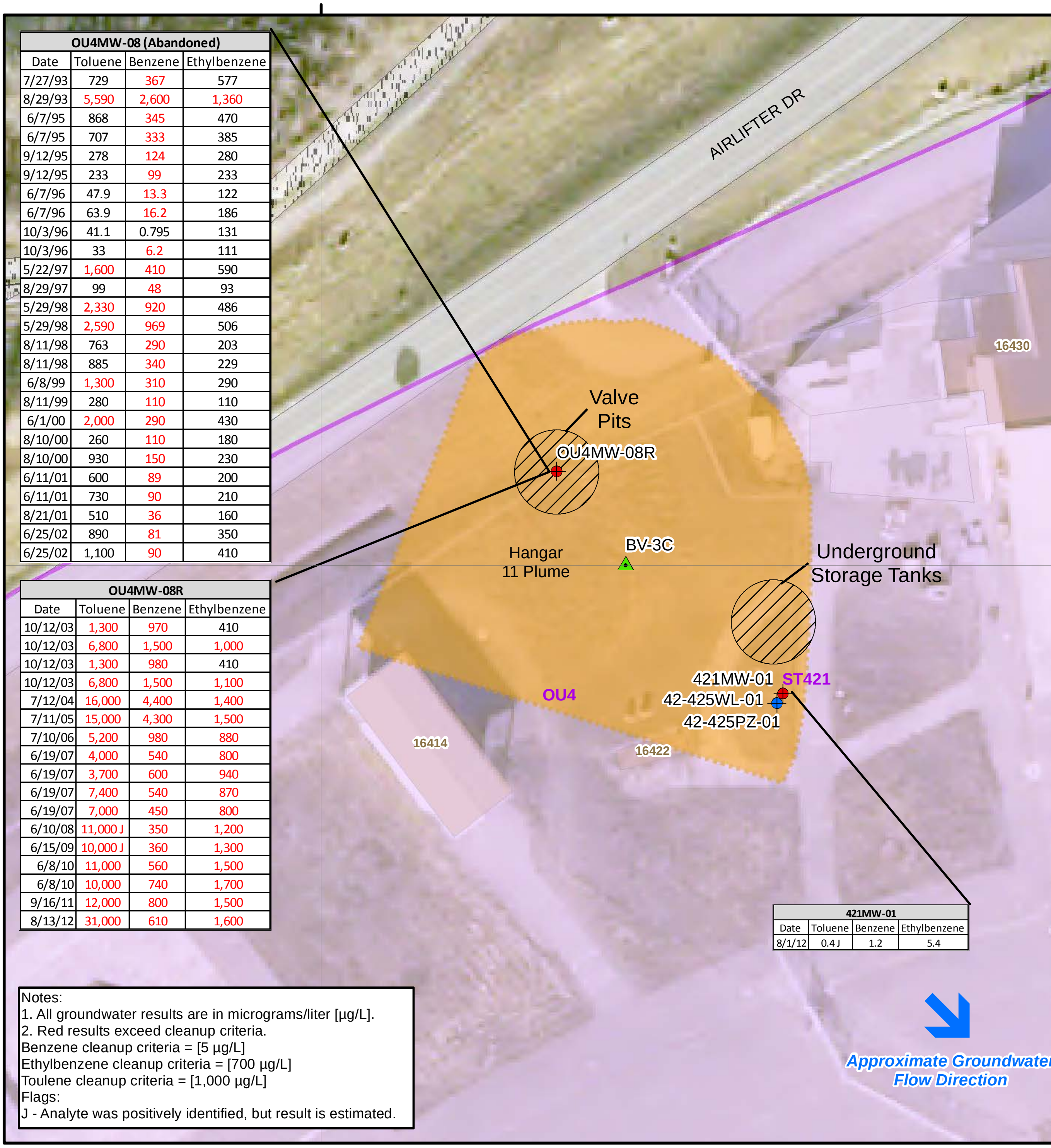
N

SD024 SITE MAP
WITH HISTORICAL DATA

JOINT BASE ELMENDORF-RICHARDSON, ALASKA

	DATE:	PROJECT MANAGER:	FIGURE NO:
JACOBS	05 MAR 2014	K. MAHER	C-4

P:\JBER\AFCEE-08\TO142_FiveYearReview\MXD\Elmendorf5Yr_2013\SD24_SiteMapAndWells.mxd beatycj



OU4MW-08 (Abandoned)

Date	Toluene	Benzene	Ethylbenzene
7/27/93	729	367	577
8/29/93	5,590	2,600	1,360
6/7/95	868	345	470
6/7/95	707	333	385
9/12/95	278	124	280
9/12/95	233	99	233
6/7/96	47.9	13.3	122
6/7/96	63.9	16.2	186
10/3/96	41.1	0.795	131
10/3/96	33	6.2	111
5/22/97	1,600	410	590
8/29/97	99	48	93
5/29/98	2,330	920	486
5/29/98	2,590	969	506
8/11/98	763	290	203
8/11/98	885	340	229
6/8/99	1,300	310	290
8/11/99	280	110	110
6/1/00	2,000	290	430
8/10/00	260	110	180
8/10/00	930	150	230
6/11/01	600	89	200
6/11/01	730	90	210
8/21/01	510	36	160
6/25/02	890	81	350
6/25/02	1,100	90	410

OU4MW-08R

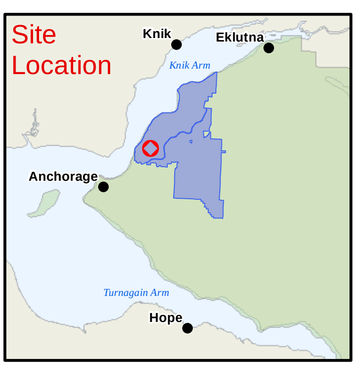
Date	Toluene	Benzene	Ethylbenzene
10/12/03	1,300	970	410
10/12/03	6,800	1,500	1,000
10/12/03	1,300	980	410
10/12/03	6,800	1,500	1,100
7/12/04	16,000	4,400	1,400
7/11/05	15,000	4,300	1,500
7/10/06	5,200	980	880
6/19/07	4,000	540	800
6/19/07	3,700	600	940
6/19/07	7,400	540	870
6/19/07	7,000	450	800
6/10/08	11,000 J	350	1,200
6/15/09	10,000 J	360	1,300
6/8/10	11,000	560	1,500
6/8/10	10,000	740	1,700
9/16/11	12,000	800	1,500
8/13/12	31,000	610	1,600

421MW-01

Date	Toluene	Benzene	Ethylbenzene
8/1/12	0.4 J	1.2	5.4

Notes:
1. All groundwater results are in micrograms/liter [µg/L].
2. Red results exceed cleanup criteria.
Benzene cleanup criteria = [5 µg/L]
Ethylbenzene cleanup criteria = [700 µg/L]
Toulene cleanup criteria = [1,000 µg/L]
Flags:
J - Analyte was positively identified, but result is estimated.

Image Source: Aero-Metric, 2012

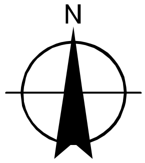


- Program Monitoring Well
- Non-Program Monitoring Well
- Non-Program Bioventing Well
- Source Area (Approximate)
- Inferred Plume Boundary (Fuels)
- Land Use Control Boundary
- Building

All Locations Are Approximate

0 25 50 75 100
Feet

WGS 1984 UTM Zone 6N

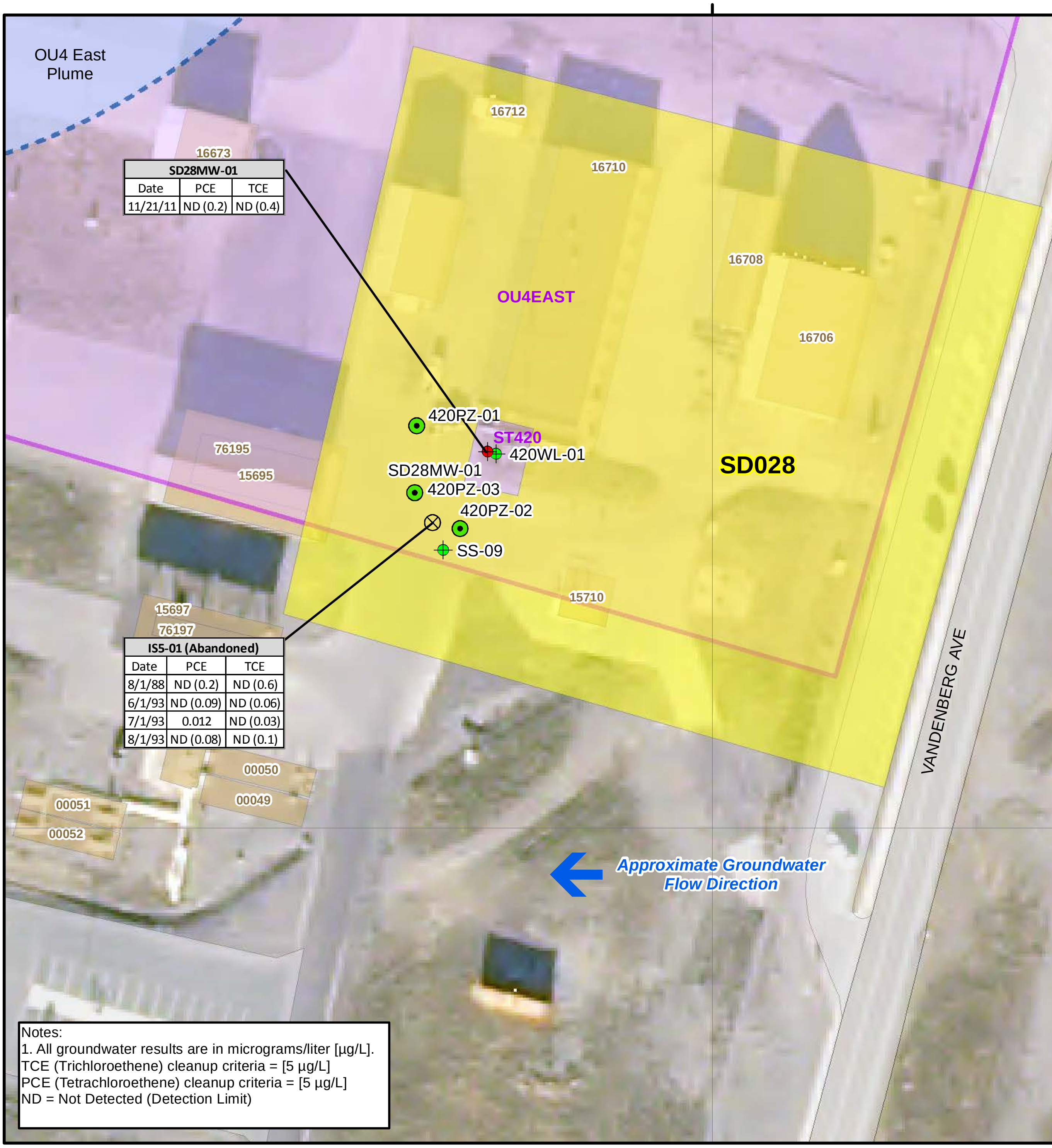


SD025 SITE MAP
WITH HISTORICAL DATA

JOINT BASE ELMENDORF-RICHARDSON, ALASKA

JACOBS	DATE: 05 MAR 2014	PROJECT MANAGER: K. MAHER	FIGURE NO: C-5

P:\JBER\AFCEE-08\TO142_FiveYearReview\MXD\Elmendorf5Yr_2013\SD25_SiteMapAndWells.mxd beatycj

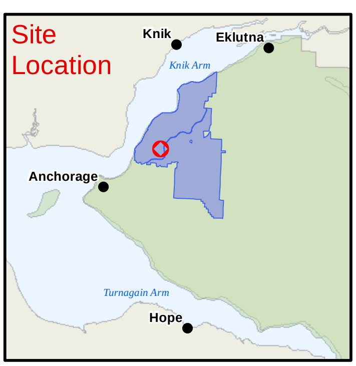


SD28MW-01		
Date	PCE	TCE
11/21/11	ND (0.2)	ND (0.4)

IS5-01 (Abandoned)		
Date	PCE	TCE
8/1/88	ND (0.2)	ND (0.6)
6/1/93	ND (0.09)	ND (0.06)
7/1/93	0.012	ND (0.03)
8/1/93	ND (0.08)	ND (0.1)

Notes:
1. All groundwater results are in micrograms/liter [µg/L].
TCE (Trichloroethene) cleanup criteria = [5 µg/L]
PCE (Tetrachloroethene) cleanup criteria = [5 µg/L]
ND = Not Detected (Detection Limit)

Image Source: Aero-Metric, 2012



Abandoned Monitoring Well
Non-Program Monitoring Well
Program Monitoring Well
Piezometer Well

Inferred Groundwater Plume (Fuels & Solvents)
CERCLA Site Boundary
Land Use Control Boundary
Building

All Locations Are Approximate
0 25 50 75 100
Feet
WGS 1984 UTM Zone 6N

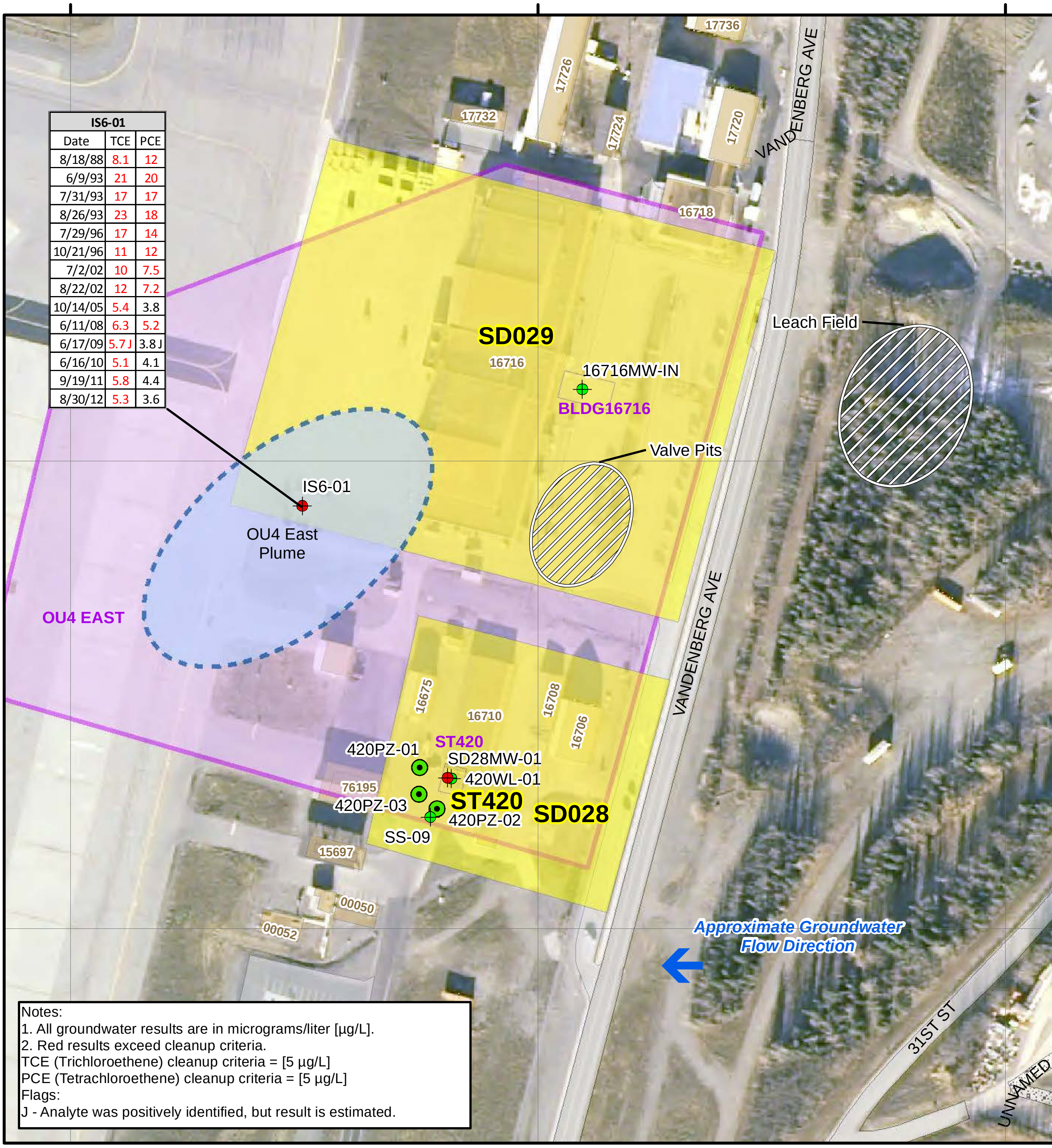
N

SD028 SITE MAP
WITH HISTORICAL DATA

JOINT BASE ELMENDORF-RICHARDSON, ALASKA

	DATE:	PROJECT MANAGER:	FIGURE NO:
JACOBS	05 MAR 2014	K. MAHER	C-6

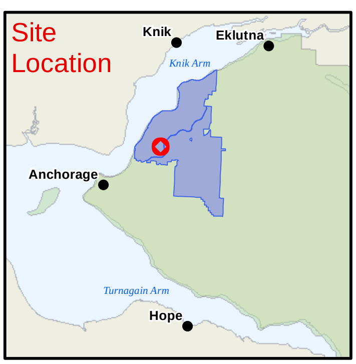
P:\JBER\AFCEE-08\TO142_FiveYearReview\MXD\Elmendorf5Yr_2013\SD28_SiteMapAndWells.mxd beatycj



IS6-01		
Date	TCE	PCE
8/18/88	8.1	12
6/9/93	21	20
7/31/93	17	17
8/26/93	23	18
7/29/96	17	14
10/21/96	11	12
7/2/02	10	7.5
8/22/02	12	7.2
10/14/05	5.4	3.8
6/11/08	6.3	5.2
6/17/09	5.7 J	3.8 J
6/16/10	5.1	4.1
9/19/11	5.8	4.4
8/30/12	5.3	3.6

Notes:
1. All groundwater results are in micrograms/liter [µg/L].
2. Red results exceed cleanup criteria.
TCE (Trichloroethene) cleanup criteria = [5 µg/L]
PCE (Tetrachloroethene) cleanup criteria = [5 µg/L]
Flags:
J - Analyte was positively identified, but result is estimated.

Image Source: Aero-Metric, 2012



Program Monitoring Well
Non-Program Monitoring Well
Piezometer Well
Source Area
Inferred Groundwater Plume (Fuels & Solvents)
CERCLA Site Boundary
Land Use Control Boundary
Building

All Locations Are Approximate
0 100 200 300 400
Feet
WGS 1984 UTM Zone 6N

N

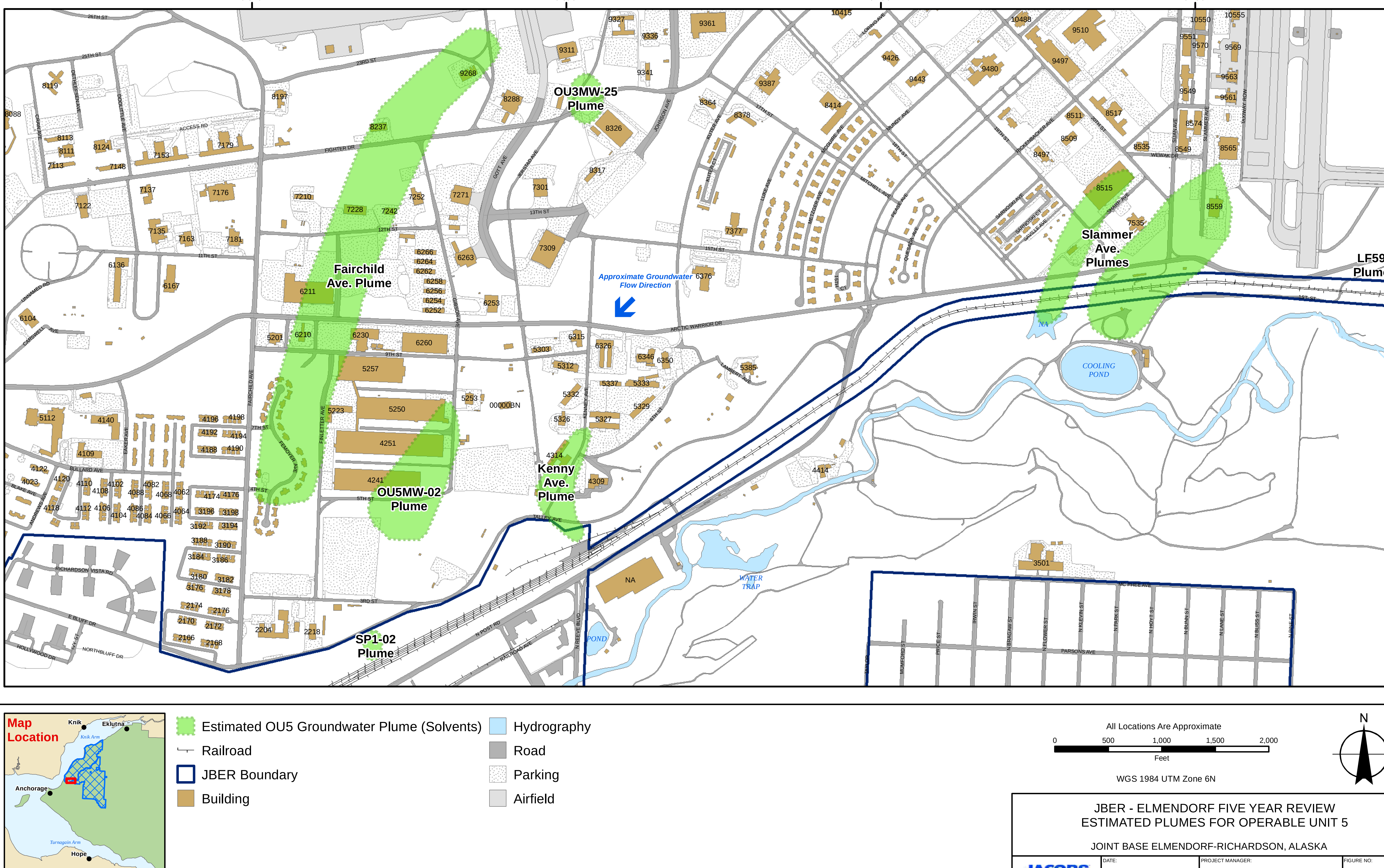
SD029 SITE MAP
WITH HISTORICAL DATA

JOINT BASE ELMENDORF-RICHARDSON, ALASKA

JACOBS

DATE:	PROJECT MANAGER:	FIGURE NO:
05 MAR 2014	K. MAHER	C-7

P:\JBER\AFCEE-08\TO142_FiveYearReview\MXD\Elmendorf5Yr_2013\SD29_SiteMapAndWells.mxd beatycj

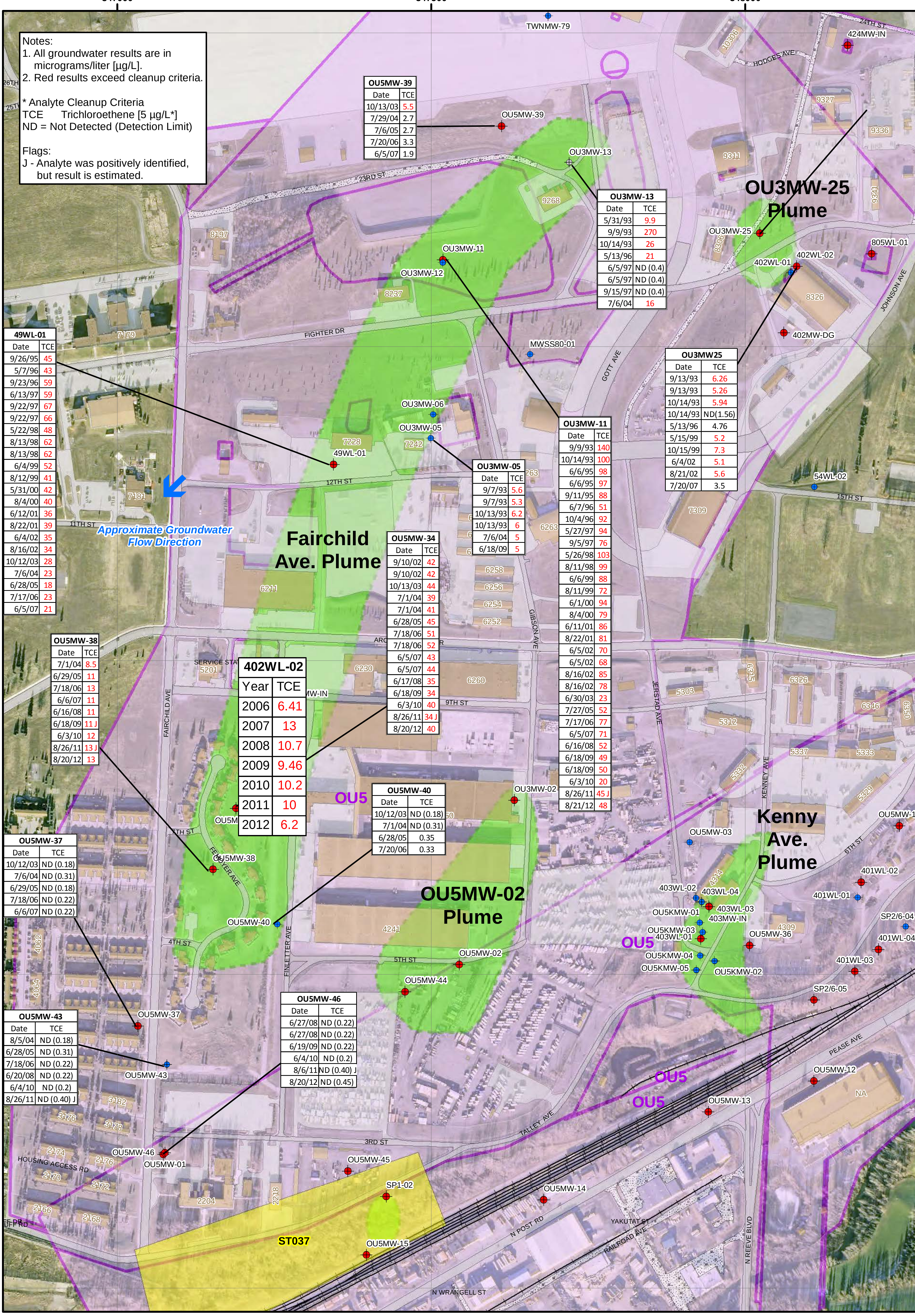


JBER - ELMENDORF FIVE YEAR REVIEW
ESTIMATED PLUMES FOR OPERABLE UNIT 5

JOINT BASE ELMENDORF-RICHARDSON, ALASKA

JACOBS	DATE: 06 MAR 2014	PROJECT MANAGER: K. MAHER	FIGURE NO: C-8

P:\JBER\AFCEE-08\TO142_FiveYearReview\MXD\Elmendorf5Yr_2013\GuideToFiguresForOU5.mxd beatyc



OU5MW-39	
Date	TCE
10/13/03	5.5
7/29/04	2.7
7/6/05	2.7
7/20/06	3.3
6/5/07	1.9

OU3MW-13	
Date	TCE
5/31/93	9.9
9/9/93	270
10/14/93	26
5/13/96	21
6/5/97	ND (0.4)
6/5/97	ND (0.4)
9/15/97	ND (0.4)
7/6/04	16

OU3MW25	
Date	TCE
9/13/93	6.26
9/13/93	5.26
10/14/93	5.94
10/14/93	ND(1.56)
5/13/96	4.76
5/15/99	5.2
10/15/99	7.3
6/4/02	5.1
8/21/02	5.6
7/20/07	3.5

49WL-01	
Date	TCE
9/26/95	45
5/7/96	43
9/23/96	59
6/13/97	59
9/22/97	67
9/22/97	66
5/22/98	48
8/13/98	62
8/13/98	62
6/4/99	52
8/12/99	41
5/31/00	42
8/4/00	40
6/12/01	36
8/22/01	39
6/4/02	35
8/16/02	34
10/12/03	28
7/6/04	23
6/28/05	18
7/17/06	23
6/5/07	21

OU3MW-11	
Date	TCE
9/9/93	140
10/14/93	100
6/6/95	98
6/6/95	97
9/11/95	88
6/7/96	51
10/4/96	92
5/27/97	94
9/5/97	76
5/26/98	103
8/11/98	99
6/6/99	88
8/11/99	72
6/1/00	94
8/4/00	79
6/11/01	86
8/22/01	81
6/5/02	70
6/5/02	68
8/16/02	85
8/16/02	78
6/30/03	23
7/27/05	52
7/17/06	77
6/5/07	71
6/16/08	52
6/18/09	49
6/18/09	50
6/3/10	20
8/26/11	45 J
8/21/12	48

OU3MW-05	
Date	TCE
9/7/93	5.6
9/7/93	5.3
10/13/93	6.2
10/13/93	6
7/6/04	5
6/18/09	5

OU5MW-34	
Date	TCE
9/10/02	42
9/10/02	42
10/13/03	44
7/1/04	39
7/1/04	41
6/28/05	45
7/18/06	51
7/18/06	52
6/5/07	43
6/5/07	44
6/17/08	35
6/18/09	34
6/3/10	40
8/26/11	34 J
8/20/12	40

OU5MW-38	
Date	TCE
7/1/04	8.5
6/29/05	11
7/18/06	13
6/6/07	11
6/16/08	11
6/18/09	11 J
6/3/10	12
8/26/11	13 J
8/20/12	13

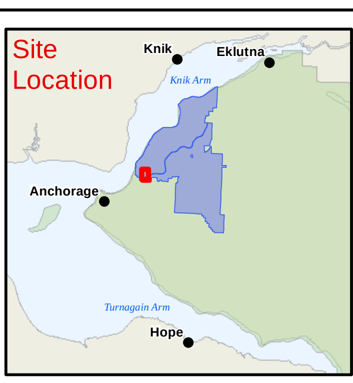
402WL-02	
Year	TCE
2006	6.41
2007	13
2008	10.7
2009	9.46
2010	10.2
2011	10
2012	6.2

OU5MW-40	
Date	TCE
10/12/03	ND (0.18)
7/1/04	ND (0.31)
6/28/05	0.35
7/20/06	0.33

OU5MW-37	
Date	TCE
10/12/03	ND (0.18)
7/6/04	ND (0.31)
6/29/05	ND (0.18)
7/18/06	ND (0.22)
6/6/07	ND (0.22)

OU5MW-43	
Date	TCE
8/5/04	ND (0.18)
6/28/05	ND (0.31)
7/18/06	ND (0.22)
6/20/08	ND (0.22)
6/4/10	ND (0.2)
8/26/11	ND (0.40) J

OU5MW-46	
Date	TCE
6/27/08	ND (0.22)
6/27/08	ND (0.22)
6/19/09	ND (0.22)
6/4/10	ND (0.2)
8/6/11	ND (0.40) J
8/20/12	ND (0.45)



Program Monitoring Well
Non-Program Monitoring Well
Abandoned Monitoring Well
Estimated Groundwater Plume (Solvents)
CERCLA Site
Land Use Control Boundary

N

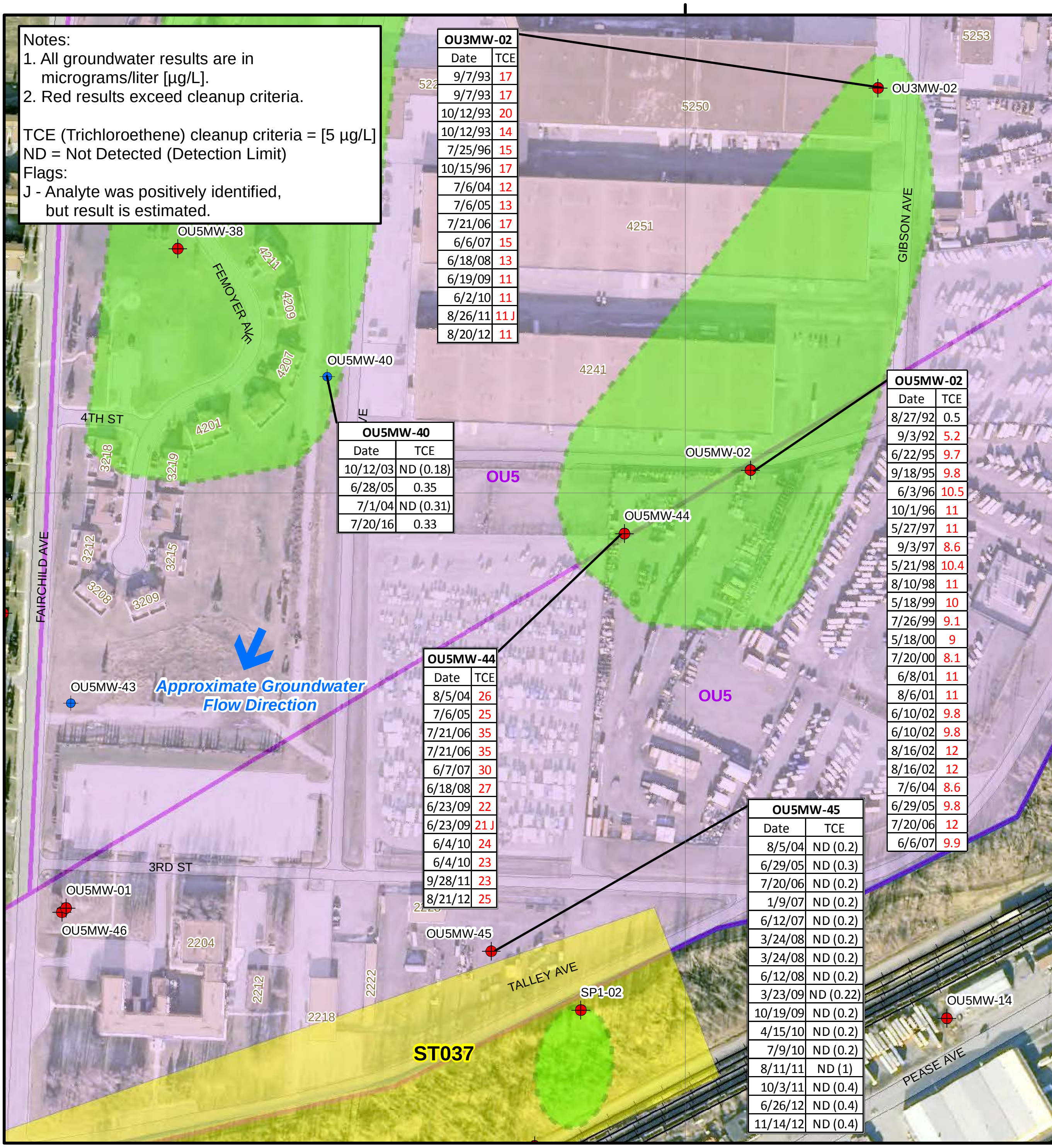
All Locations Are Approximate
0 200 400 600 800
Feet
WGS 1984 UTM Zone 6N

FAIRCHILD AVENUE PLUME SITE MAP
AND HISTORICAL DATA

JOINT BASE ELMENDORF-RICHARDSON, ALASKA

	DATE:	PROJECT MANAGER:	FIGURE NO:
JACOBS	06 MAR 2014	K. MAHER	C-9

P:\BER\AFCEE-08\TO142_FiveYearReview\MXD\Elmendorf5Yr_2013\FairchildAve_SiteMapAndWells.mxd beatycj



OU3MW-02	
Date	TCE
9/7/93	17
9/7/93	17
10/12/93	20
10/12/93	14
7/25/96	15
10/15/96	17
7/6/04	12
7/6/05	13
7/21/06	17
6/6/07	15
6/18/08	13
6/19/09	11
6/2/10	11
8/26/11	11 J
8/20/12	11

OU5MW-40	
Date	TCE
10/12/03	ND (0.18)
6/28/05	0.35
7/1/04	ND (0.31)
7/20/16	0.33

OU5MW-02	
Date	TCE
8/27/92	0.5
9/3/92	5.2
6/22/95	9.7
9/18/95	9.8
6/3/96	10.5
10/1/96	11
5/27/97	11
9/3/97	8.6
5/21/98	10.4
8/10/98	11
5/18/99	10
7/26/99	9.1
5/18/00	9
7/20/00	8.1
6/8/01	11
8/6/01	11
6/10/02	9.8
6/10/02	9.8
8/16/02	12
8/16/02	12
7/6/04	8.6
6/29/05	9.8
7/20/06	12
6/6/07	9.9

OU5MW-44	
Date	TCE
8/5/04	26
7/6/05	25
7/21/06	35
7/21/06	35
6/7/07	30
6/18/08	27
6/23/09	22
6/23/09	21 J
6/4/10	24
6/4/10	23
9/28/11	23
8/21/12	25

OU5MW-45	
Date	TCE
8/5/04	ND (0.2)
6/29/05	ND (0.3)
7/20/06	ND (0.2)
1/9/07	ND (0.2)
6/12/07	ND (0.2)
3/24/08	ND (0.2)
3/24/08	ND (0.2)
6/12/08	ND (0.2)
3/23/09	ND (0.22)
10/19/09	ND (0.2)
4/15/10	ND (0.2)
7/9/10	ND (0.2)
8/11/11	ND (1)
10/3/11	ND (0.4)
6/26/12	ND (0.4)
11/14/12	ND (0.4)

Image Source: Aero-Metric, 2012

Program Monitoring Well
Non-Program Monitoring Well
Estimated Groundwater Plume (Solvents)
CERCLA Site
Land Use Control Boundary
JBER Boundary

All Locations Are Approximate
0 100 200 300 400
Feet
WGS 1984 UTM Zone 6N

N

OU5MW-02 PLUME SITE MAP AND HISTORICAL DATA

JOINT BASE ELMENDORF-RICHARDSON, ALASKA

JACOBS

DATE:	PROJECT MANAGER:	FIGURE NO:
06 MAR 2014	K. MAHER	C-10

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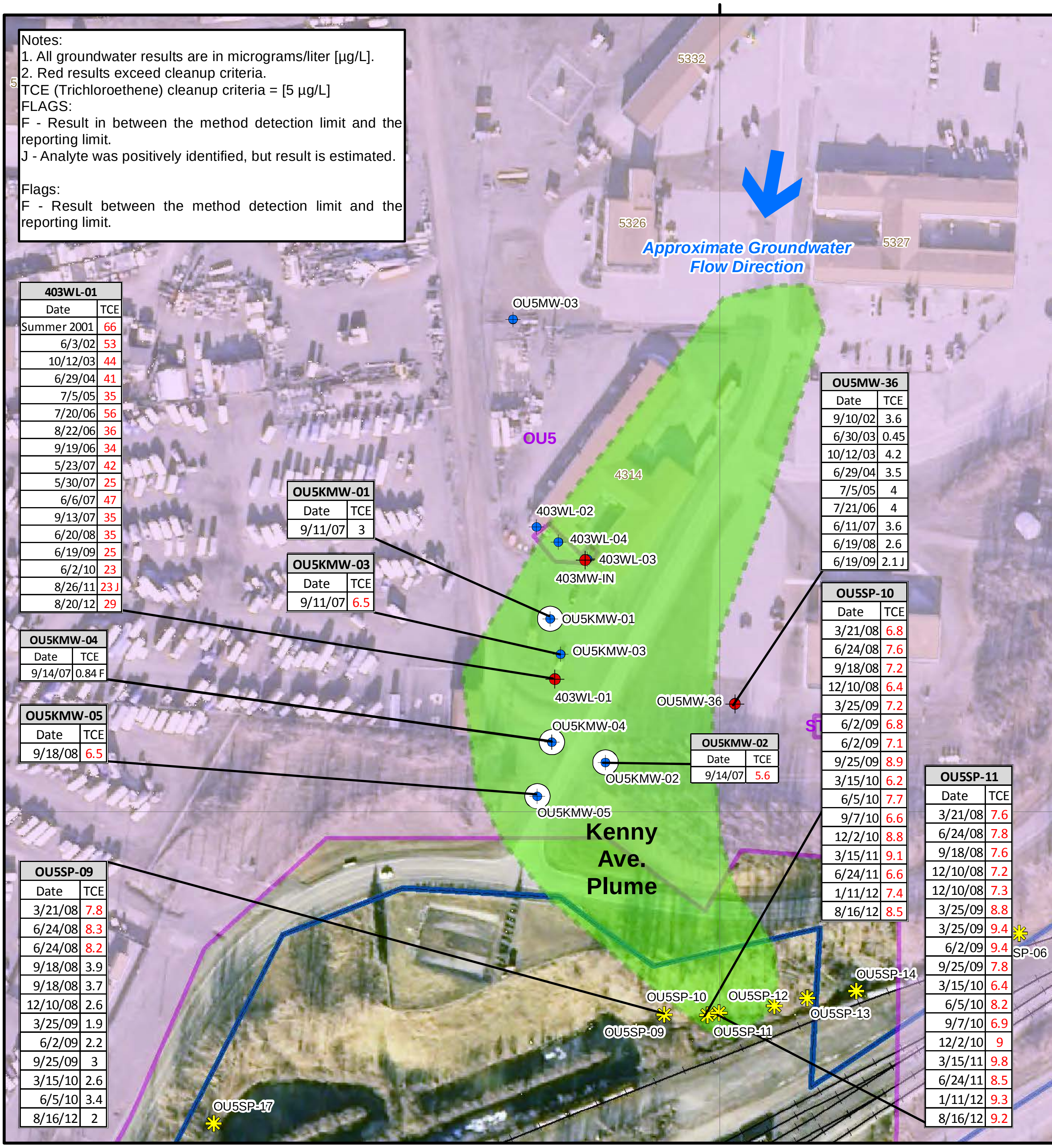
Notes:
1. All groundwater results are in micrograms/liter [µg/L].
2. Red results exceed cleanup criteria.
TCE (Trichloroethene) cleanup criteria = [5 µg/L]
FLAGS:
F - Result in between the method detection limit and the reporting limit.
J - Analyte was positively identified, but result is estimated.

Flags:
F - Result between the method detection limit and the reporting limit.



403WL-01	
Date	TCE
Summer 2001	66
6/3/02	53
10/12/03	44
6/29/04	41
7/5/05	35
7/20/06	56
8/22/06	36
9/19/06	34
5/23/07	42
5/30/07	25
6/6/07	47
9/13/07	35
6/20/08	35
6/19/09	25
6/2/10	23
8/26/11	23 J
8/20/12	29

OU5KMW-01	
Date	TCE
9/11/07	3

OU5KMW-03	
Date	TCE
9/11/07	6.5

OU5KMW-04	
Date	TCE
9/14/07	0.84 F

OU5KMW-05	
Date	TCE
9/18/08	6.5

OU5KMW-02	
Date	TCE
9/14/07	5.6

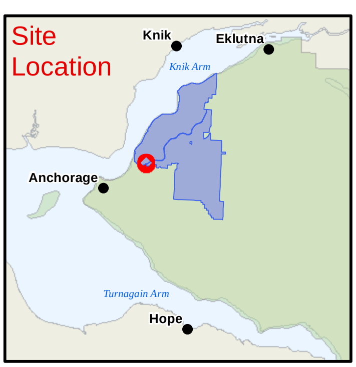
OU5MW-36	
Date	TCE
9/10/02	3.6
6/30/03	0.45
10/12/03	4.2
6/29/04	3.5
7/5/05	4
7/21/06	4
6/11/07	3.6
6/19/08	2.6
6/19/09	2.1 J

OU5SP-10	
Date	TCE
3/21/08	6.8
6/24/08	7.6
9/18/08	7.2
12/10/08	6.4
3/25/09	7.2
6/2/09	6.8
6/2/09	7.1
9/25/09	8.9
3/15/10	6.2
6/5/10	7.7
9/7/10	6.6
12/2/10	8.8
3/15/11	9.1
6/24/11	6.6
1/11/12	7.4
8/16/12	8.5

OU5SP-11	
Date	TCE
3/21/08	7.6
6/24/08	7.8
9/18/08	7.6
12/10/08	7.2
12/10/08	7.3
3/25/09	8.8
3/25/09	9.4
6/2/09	9.4
9/25/09	7.8
3/15/10	6.4
6/5/10	8.2
9/7/10	6.9
12/2/10	9
3/15/11	9.8
6/24/11	8.5
1/11/12	9.3
8/16/12	9.2

OU5SP-09	
Date	TCE
3/21/08	7.8
6/24/08	8.3
6/24/08	8.2
9/18/08	3.9
9/18/08	3.7
12/10/08	2.6
3/25/09	1.9
6/2/09	2.2
9/25/09	3
3/15/10	2.6
6/5/10	3.4
8/16/12	2

Image Source: Aero-Metric, 2012



Seep Sample Location
Program Monitoring Well
Non-Program Monitoring Well
Treatability Study Well
Estimated Groundwater Plume (Solvents)
Land Use Control Boundary
JBER Boundary

All Locations Are Approximate
0 75 150 225 300
Feet
WGS 1984 UTM Zone 6N

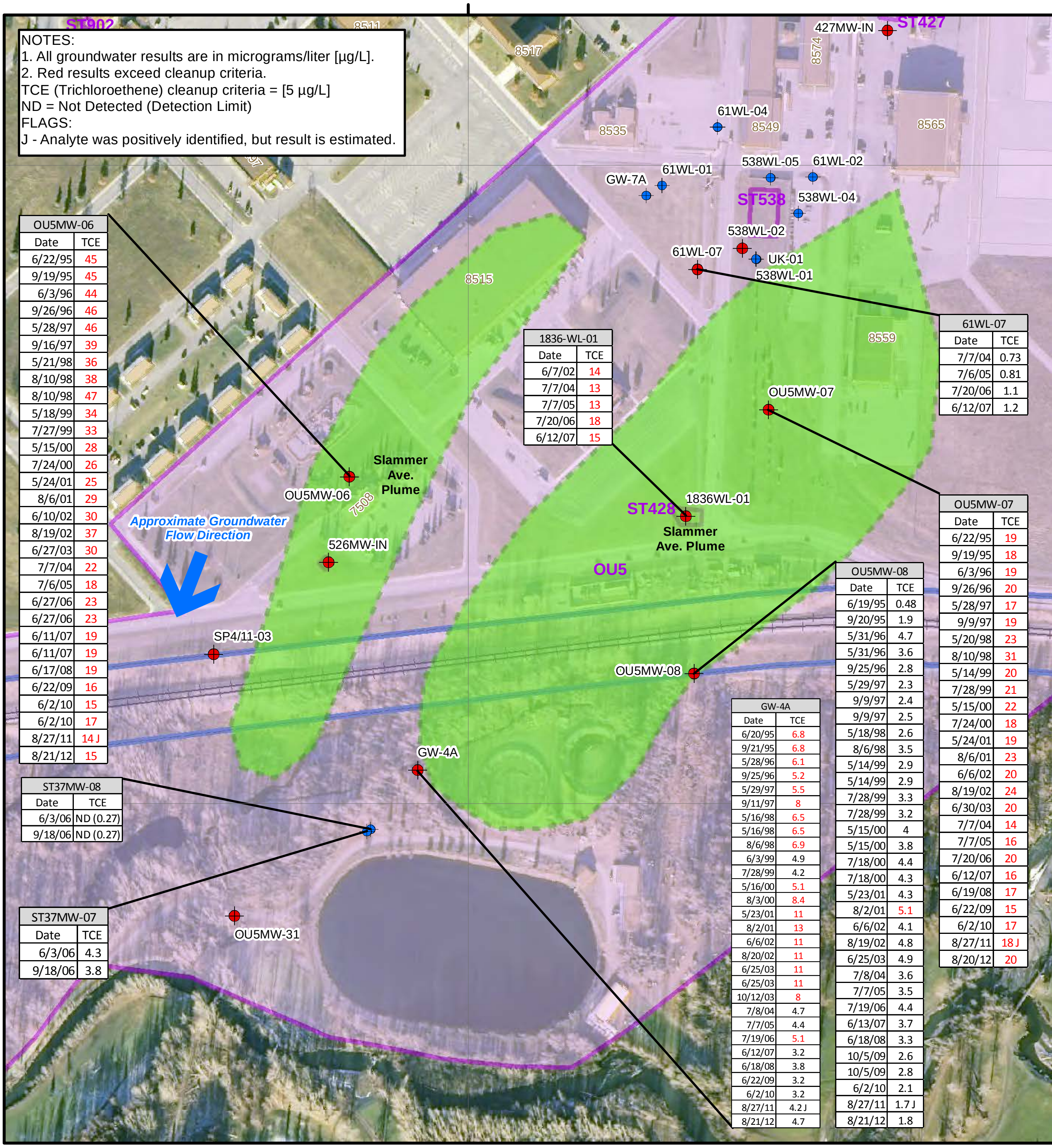
N

KENNEY AVENUE PLUME SITE MAP AND HISTORICAL DATA

JOINT BASE ELMENDORF-RICHARDSON, ALASKA

	DATE:	PROJECT MANAGER:	FIGURE NO:
JACOBS	06 MAR 2014	K. MAHER	C-11

P:\JBER\AFCEE-08\TO142_FiveYearReview\MXD\Elmendorf5Yr_2013\KennyAvePlume_SiteMapAndWells.mxd beatycj



NOTES:
1. All groundwater results are in micrograms/liter [µg/L].
2. Red results exceed cleanup criteria.
TCE (Trichloroethene) cleanup criteria = [5 µg/L]
ND = Not Detected (Detection Limit)
FLAGS:
J - Analyte was positively identified, but result is estimated.

OU5MW-06

Date	TCE
6/22/95	45
9/19/95	45
6/3/96	44
9/26/96	46
5/28/97	46
9/16/97	39
5/21/98	36
8/10/98	38
8/10/98	47
5/18/99	34
7/27/99	33
5/15/00	28
7/24/00	26
5/24/01	25
8/6/01	29
6/10/02	30
8/19/02	37
6/27/03	30
7/7/04	22
7/6/05	18
6/27/06	23
6/27/06	23
6/11/07	19
6/11/07	19
6/17/08	19
6/22/09	16
6/2/10	15
6/2/10	17
8/27/11	14 J
8/21/12	15

1836-WL-01

Date	TCE
6/7/02	14
7/7/04	13
7/7/05	13
7/20/06	18
6/12/07	15

61WL-07

Date	TCE
7/7/04	0.73
7/6/05	0.81
7/20/06	1.1
6/12/07	1.2

OU5MW-07

Date	TCE
6/22/95	19
9/19/95	18
6/3/96	19
9/26/96	20
5/28/97	17
9/9/97	19
5/20/98	23
8/10/98	31
5/14/99	20
7/28/99	21
5/15/00	22
7/24/00	18
5/24/01	19
8/6/01	23
6/6/02	20
8/19/02	24
6/30/03	20
7/7/04	14
7/7/05	16
7/20/06	20
6/12/07	16
6/19/08	17
6/22/09	15
6/2/10	17
8/27/11	18 J
8/20/12	20

OU5MW-08

Date	TCE
6/19/95	0.48
9/20/95	1.9
5/31/96	4.7
5/31/96	3.6
9/25/96	2.8
5/29/97	2.3
9/9/97	2.4
9/9/97	2.5
5/18/98	2.6
8/6/98	3.5
5/14/99	2.9
5/14/99	2.9
7/28/99	3.3
7/28/99	3.2
5/15/00	4
5/15/00	3.8
7/18/00	4.4
7/18/00	4.3
5/23/01	4.3
8/2/01	5.1
6/6/02	4.1
8/19/02	4.8
6/25/03	4.9
7/8/04	3.6
7/7/05	3.5
7/19/06	4.4
6/13/07	3.7
6/18/08	3.3
10/5/09	2.6
10/5/09	2.8
6/2/10	2.1
8/27/11	1.7 J
8/21/12	1.8

GW-4A

Date	TCE
6/20/95	6.8
9/21/95	6.8
5/28/96	6.1
9/25/96	5.2
5/29/97	5.5
9/11/97	8
5/16/98	6.5
5/16/98	6.5
8/6/98	6.9
6/3/99	4.9
7/28/99	4.2
5/16/00	5.1
8/3/00	8.4
5/23/01	11
8/2/01	13
6/6/02	11
8/20/02	11
6/25/03	11
6/25/03	11
10/12/03	8
7/8/04	4.7
7/7/05	4.4
7/19/06	5.1
6/12/07	3.2
6/18/08	3.8
6/22/09	3.2
6/2/10	3.2
8/27/11	4.2 J
8/21/12	4.7

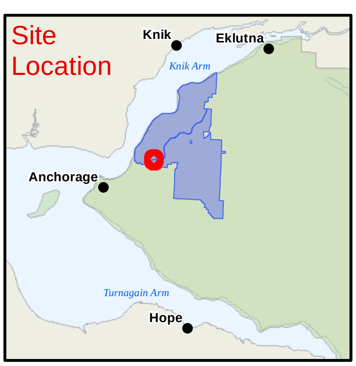
ST37MW-08

Date	TCE
6/3/06	ND (0.27)
9/18/06	ND (0.27)

ST37MW-07

Date	TCE
6/3/06	4.3
9/18/06	3.8

Image Source: Aero-Metric, 2012



Program Monitoring Well
Non-Program Monitoring Well
Estimated Groundwater Plume (Solvents)
Land Use Control Boundary
JBER Boundary

All Locations Are Approximate
0 100 200 300 400 500
Feet
WGS 1984 UTM Zone 6N

N

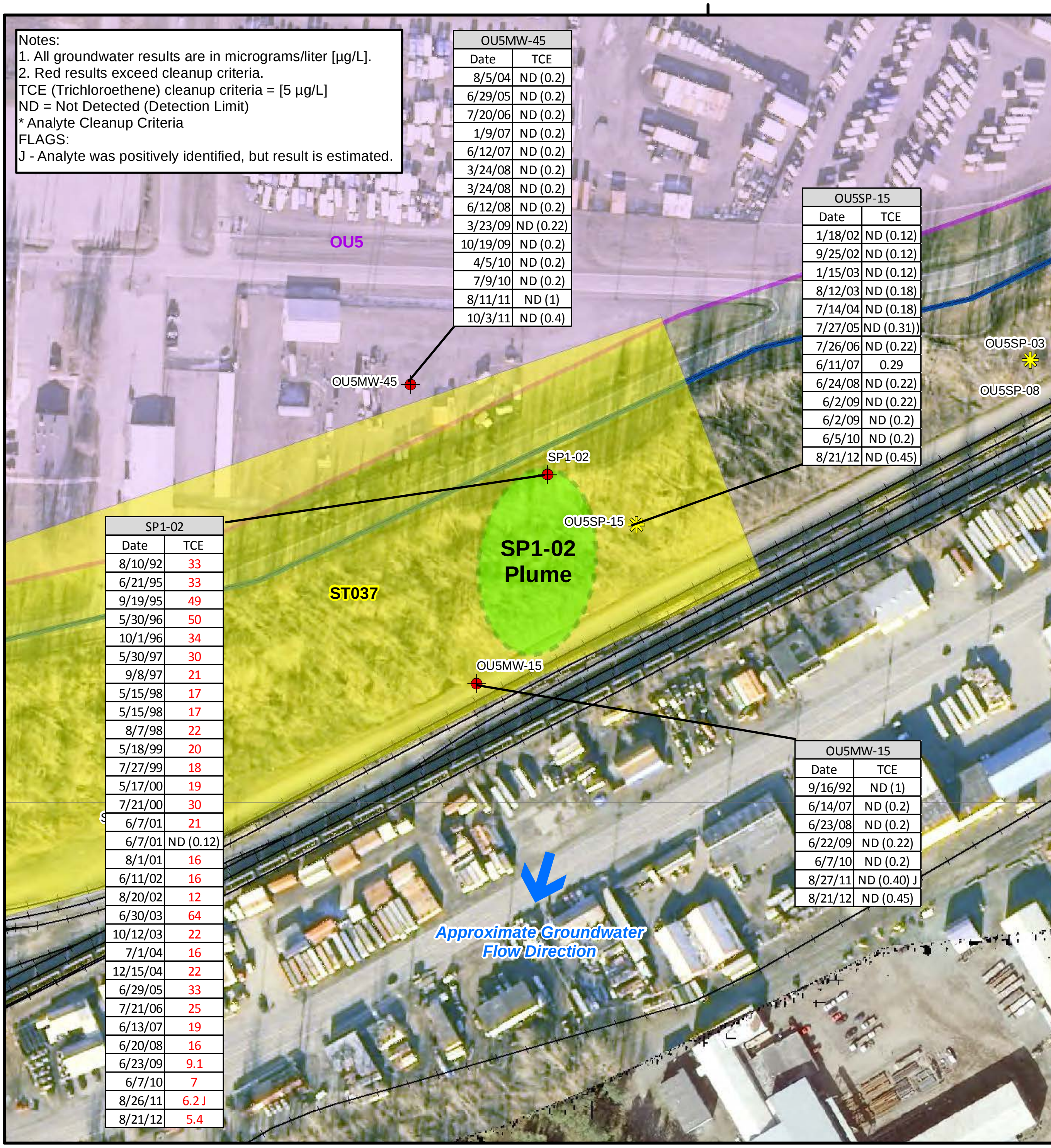
SLAMMER AVENUE PLUME SITE MAP AND HISTORICAL DATA

JOINT BASE ELMENDORF-RICHARDSON, ALASKA

JACOBS	DATE: 06 MAR 2014	PROJECT MANAGER: K. MAHER	FIGURE NO: C-12

P:\JBER\AFCEE-08\TO142_FiveYearReview\MXD\Elmendorf5Yr_2013\SlammerAvePlume_SiteMapAndWells.mxd beatycj

Notes:
1. All groundwater results are in micrograms/liter [µg/L].
2. Red results exceed cleanup criteria.
TCE (Trichloroethene) cleanup criteria = [5 µg/L]
ND = Not Detected (Detection Limit)
* Analyte Cleanup Criteria
FLAGS:
J - Analyte was positively identified, but result is estimated.



OU5MW-45	
Date	TCE
8/5/04	ND (0.2)
6/29/05	ND (0.2)
7/20/06	ND (0.2)
1/9/07	ND (0.2)
6/12/07	ND (0.2)
3/24/08	ND (0.2)
3/24/08	ND (0.2)
6/12/08	ND (0.2)
3/23/09	ND (0.22)
10/19/09	ND (0.2)
4/5/10	ND (0.2)
7/9/10	ND (0.2)
8/11/11	ND (1)
10/3/11	ND (0.4)

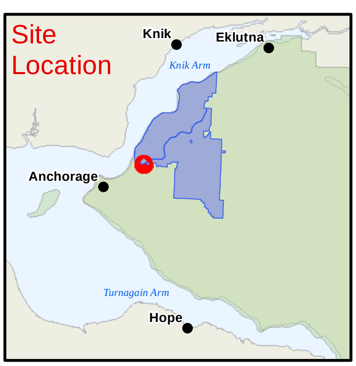
OU5SP-15	
Date	TCE
1/18/02	ND (0.12)
9/25/02	ND (0.12)
1/15/03	ND (0.12)
8/12/03	ND (0.18)
7/14/04	ND (0.18)
7/27/05	ND (0.31)
7/26/06	ND (0.22)
6/11/07	0.29
6/24/08	ND (0.22)
6/2/09	ND (0.22)
6/2/09	ND (0.2)
6/5/10	ND (0.2)
8/21/12	ND (0.45)

SP1-02	
Date	TCE
8/10/92	33
6/21/95	33
9/19/95	49
5/30/96	50
10/1/96	34
5/30/97	30
9/8/97	21
5/15/98	17
5/15/98	17
8/7/98	22
5/18/99	20
7/27/99	18
5/17/00	19
7/21/00	30
6/7/01	21
6/7/01	ND (0.12)
8/1/01	16
6/11/02	16
8/20/02	12
6/30/03	64
10/12/03	22
7/1/04	16
12/15/04	22
6/29/05	33
7/21/06	25
6/13/07	19
6/20/08	16
6/23/09	9.1
6/7/10	7
8/26/11	6.2 J
8/21/12	5.4

OU5MW-15	
Date	TCE
9/16/92	ND (1)
6/14/07	ND (0.2)
6/23/08	ND (0.2)
6/22/09	ND (0.22)
6/7/10	ND (0.2)
8/27/11	ND (0.40) J
8/21/12	ND (0.45)

Image Source: Aero-Metric, 2012

Site Location



Seep Sample Location
Program Monitoring Well
Estimated Groundwater Plume (Solvents)
CERCLA Site Boundary
Land Use Control Boundary
JBER Boundary

All Locations Are Approximate
0 100 200 300 400
Feet
WGS 1984 UTM Zone 6N

N

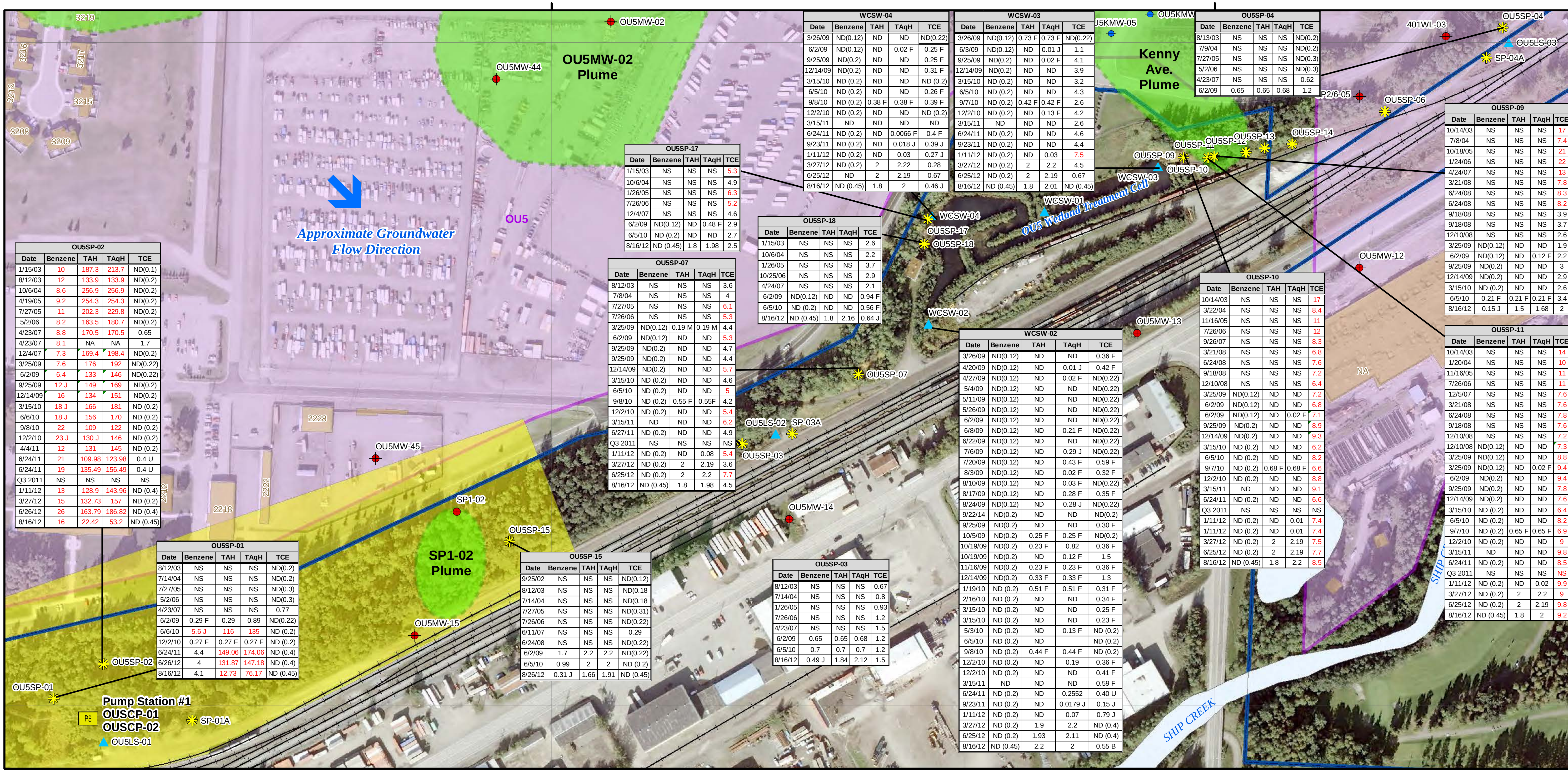
SP1-2 PLUME SITE MAP AND HISTORICAL DATA

JOINT BASE ELMENDORF-RICHARDSON, ALASKA

JACOBS

DATE:	PROJECT MANAGER:	FIGURE NO:
06 MAR 2014	K. MAHER	C-13

P:\JBER\AFCEE-08\TO142_FiveYearReview\MXD\Elmendorf5Yr_2013\SP01-2_SiteMapAndWells.mxd beatycj



OU5SP-02				
Date	Benzene	TAH	TAqH	TCE
1/15/03	10	187.3	213.7	ND(0.1)
8/12/03	12	133.9	133.9	ND(0.2)
10/6/04	8.6	256.9	256.9	ND(0.2)
4/19/05	9.2	254.3	254.3	ND(0.2)
7/27/05	11	202.3	229.8	ND(0.2)
5/2/06	8.2	163.5	180.7	ND(0.2)
4/23/07	8.8	170.5	170.5	0.65
4/23/07	8.1	NA	NA	1.7
12/4/07	7.3	169.4	198.4	ND(0.2)
3/25/09	7.6	176	192	ND(0.22)
6/2/09	6.4	133	146	ND(0.22)
9/25/09	12 J	149	169	ND(0.2)
12/14/09	16	134	151	ND(0.2)
3/15/10	18 J	166	181	ND (0.2)
6/6/10	18 J	156	170	ND (0.2)
9/8/10	22	109	122	ND (0.2)
12/2/10	23 J	130 J	146	ND (0.2)
4/4/11	12	131	145	ND (0.2)
6/24/11	21	109.98	123.98	0.4 U
6/24/11	19	135.49	156.49	0.4 U
Q3 2011	NS	NS	NS	NS
1/11/12	13	128.9	143.96	ND (0.4)
3/27/12	15	132.73	157	ND (0.2)
6/26/12	26	163.79	186.82	ND (0.4)
8/16/12	16	22.42	53.2	ND (0.45)

OU5SP-01				
Date	Benzene	TAH	TAqH	TCE
8/12/03	NS	NS	NS	ND(0.2)
7/14/04	NS	NS	NS	ND(0.2)
7/27/05	NS	NS	NS	ND(0.3)
5/2/06	NS	NS	NS	ND(0.3)
4/23/07	NS	NS	NS	0.77
6/2/09	0.29 F	0.29	0.89	ND(0.22)
6/6/10	5.6 J	116	135	ND (0.2)
12/2/10	0.27 F	0.27 F	0.27 F	ND (0.2)
6/24/11	4.4	149.06	174.06	ND (0.4)
6/26/12	4	131.87	147.18	ND (0.4)
8/16/12	4.1	12.73	76.17	ND (0.45)

OU5SP-15				
Date	Benzene	TAH	TAqH	TCE
9/25/02	NS	NS	NS	ND(0.12)
8/12/03	NS	NS	NS	ND(0.18
7/14/04	NS	NS	NS	ND(0.18
7/27/05	NS	NS	NS	ND(0.31)
7/26/06	NS	NS	NS	ND(0.22)
6/11/07	NS	NS	NS	0.29
6/24/08	NS	NS	NS	ND(0.22)
6/2/09	1.7	2.2	2.2	ND(0.22)
6/5/10	0.99	2	2	ND (0.2)
8/26/12	0.31 J	1.66	1.91	ND (0.45)

OU5SP-17				
Date	Benzene	TAH	TAqH	TCE
1/15/03	NS	NS	NS	5.3
10/6/04	NS	NS	NS	4.9
1/26/05	NS	NS	NS	6.3
7/26/06	NS	NS	NS	5.2
12/4/07	NS	NS	NS	4.6
6/2/09	ND(0.12)	ND	0.48 F	2.9
6/5/10	ND (0.2)	ND	ND	2.7
8/16/12	ND (0.45)	1.8	1.98	2.5

OU5SP-07				
Date	Benzene	TAH	TAqH	TCE
8/12/03	NS	NS	NS	3.6
7/8/04	NS	NS	NS	4
7/27/05	NS	NS	NS	6.1
7/26/06	NS	NS	NS	5.3
3/25/09	ND(0.12)	0.19 M	0.19 M	4.4
6/2/09	ND(0.12)	ND	ND	5.3
9/25/09	ND(0.2)	ND	ND	4.7
9/25/09	ND(0.2)	ND	ND	4.4
12/14/09	ND(0.2)	ND	ND	5.7
3/15/10	ND (0.2)	ND	ND	4.6
6/5/10	ND (0.2)	ND	ND	5
9/8/10	ND (0.2)	0.55 F	0.55F	4.2
12/2/10	ND (0.2)	ND	ND	5.4
3/15/11	ND	ND	ND	6.2
6/27/11	ND (0.2)	ND	ND	4.9
Q3 2011	NS	NS	NS	NS
1/11/12	ND (0.2)	ND	0.08	5.4
3/27/12	ND (0.2)	2	2.19	3.6
6/25/12	ND (0.2)	2	2.2	7.7
8/16/12	ND (0.45)	1.8	1.98	4.5

OU5SP-18				
Date	Benzene	TAH	TAqH	TCE
1/15/03	NS	NS	NS	2.6
10/6/04	NS	NS	NS	2.2
1/26/05	NS	NS	NS	3.7
10/25/06	NS	NS	NS	2.9
4/24/07	NS	NS	NS	2.1
6/2/09	ND(0.12)	ND	ND	0.94 F
6/5/10	ND (0.2)	ND	ND	0.56 F
8/16/12	ND (0.45)	1.8	2.16	0.64 J

WCSW-04				
Date	Benzene	TAH	TAqH	TCE
3/26/09	ND(0.12)	ND	ND	ND(0.22)
6/2/09	ND(0.12)	ND	0.02 F	0.25 F
9/25/09	ND(0.2)	ND	ND	0.25 F
12/14/09	ND(0.2)	ND	ND	0.31 F
3/15/10	ND (0.2)	ND	ND	ND (0.2)
6/5/10	ND (0.2)	ND	ND	0.26 F
9/8/10	ND (0.2)	0.38 F	0.38 F	0.39 F
12/2/10	ND (0.2)	ND	ND	ND (0.2)
3/15/11	ND	ND	ND	ND
6/24/11	ND (0.2)	ND	0.0066 F	0.4 F
9/23/11	ND (0.2)	ND	0.018 J	0.39 J
1/11/12	ND (0.2)	ND	0.03	0.27 J
3/27/12	ND (0.2)	2	2.22	0.28
6/25/12	ND	2	2.19	0.67
8/16/12	ND (0.45)	1.8	2	0.46 J

WCSW-03				
Date	Benzene	TAH	TAqH	TCE
3/26/09	ND(0.12)	0.73 F	0.73 F	ND(0.22)
6/3/09	ND(0.12)	ND	0.01 J	1.1
9/25/09	ND(0.2)	ND	0.02 F	4.1
12/14/09	ND(0.2)	ND	ND	3.9
3/15/10	ND (0.2)	ND	ND	3.2
6/5/10	ND (0.2)	ND	ND	4.3
9/7/10	ND (0.2)	0.42 F	0.42 F	2.6
12/2/10	ND (0.2)	ND	0.13 F	4.2
3/15/11	ND	ND	ND	2.6
6/24/11	ND (0.2)	ND	ND	4.6
9/23/11	ND (0.2)	ND	ND	4.4
1/11/12	ND (0.2)	ND	0.03	7.5
3/27/12	ND (0.2)	2	2.2	4.5
6/25/12	ND (0.2)	2	2.19	0.67
8/16/12	ND (0.45)	1.8	2.01	ND (0.45)

OU5SP-04				
Date	Benzene	TAH	TAqH	TCE
8/13/03	NS	NS	NS	ND(0.2)
7/9/04	NS	NS	NS	ND(0.2)
7/27/05	NS	NS	NS	ND(0.3)
5/2/06	NS	NS	NS	ND(0.3)
4/23/07	NS	NS	NS	0.62
6/2/09	0.65	0.65	0.68	1.2

OU5SP-09				
Date	Benzene	TAH	TAqH	TCE
10/14/03	NS	NS	NS	17
7/8/04	NS	NS	NS	7.4
10/18/05	NS	NS	NS	21
1/24/06	NS	NS	NS	22
4/24/07	NS	NS	NS	13
3/21/08	NS	NS	NS	7.8
6/24/08	NS	NS	NS	8.3
6/24/08	NS	NS	NS	8.2
9/18/08	NS	NS	NS	3.9
9/18/08	NS	NS	NS	3.7
12/10/08	NS	NS	NS	2.6
3/25/09	ND(0.12)	ND	ND	1.9
6/2/09	ND(0.12)	ND	0.12 F	2.2
9/25/09	ND(0.2)	ND	ND	3
12/14/09	ND(0.2)	ND	ND	2.9
3/15/10	ND (0.2)	ND	ND	2.6
6/5/10	0.21 F	0.21 F	0.21 F	3.4
8/16/12	0.15 J	1.5	1.68	2

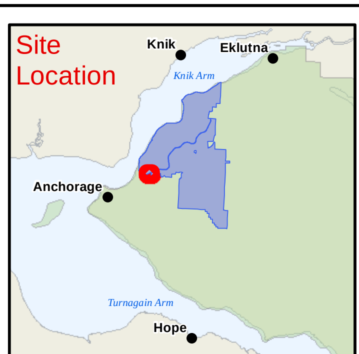
OU5SP-10				
Date	Benzene	TAH	TAqH	TCE
10/14/03	NS	NS	NS	17
3/22/04	NS	NS	NS	8.4
11/16/05	NS	NS	NS	11
7/26/06	NS	NS	NS	12
9/26/07	NS	NS	NS	8.3
3/21/08	NS	NS	NS	6.8
6/24/08	NS	NS	NS	7.6
9/18/08	NS	NS	NS	7.2
12/10/08	NS	NS	NS	6.4
3/25/09	ND(0.12)	ND	ND	7.2
6/2/09	ND(0.12)	ND	ND	6.8
6/2/09	ND(0.12)	ND	0.02 F	7.1
9/25/09	ND(0.2)	ND	ND	8.9
12/14/09	ND(0.2)	ND	ND	9.3
3/15/10	ND (0.2)	ND	ND	6.2
6/5/10	ND (0.2)	ND	ND	8.2
9/7/10	ND (0.2)	0.68 F	0.68 F	6.6
12/2/10	ND (0.2)	ND	ND	8.8
3/15/11	ND	ND	ND	9.1
6/24/11	ND (0.2)	ND	ND	6.6
Q3 2011	NS	NS	NS	NS
1/11/12	ND (0.2)	ND	0.01	7.4
1/11/12	ND (0.2)	ND	0.01	7.4
3/27/12	ND (0.2)	2	2.19	7.5
6/25/12	ND (0.2)	2	2.19	7.7
8/16/12	ND (0.45)	1.8	2.2	8.5

OU5SP-11				
Date	Benzene	TAH	TAqH	TCE
10/14/03	NS	NS	NS	14
1/20/04	NS	NS	NS	10
11/16/05	NS	NS	NS	11
7/26/06	NS	NS	NS	11
12/5/07	NS	NS	NS	7.6
3/21/08	NS	NS	NS	7.6
6/24/08	NS	NS	NS	7.8
9/18/08	NS	NS	NS	7.6
12/10/08	NS	NS	NS	7.2
12/10/08	ND(0.12)	ND	ND	7.3
3/25/09	ND(0.12)	ND	ND	8.8
3/25/09	ND(0.12)	ND	0.02 F	9.4
6/2/09	ND(0.2)	ND	ND	9.4
9/25/09	ND(0.2)	ND	ND	7.8
12/14/09	ND(0.2)	ND	ND	7.6
3/15/10	ND (0.2)	ND	ND	6.4
6/5/10	ND (0.2)	ND	ND	8.2
9/7/10	ND (0.2)	0.65 F	0.65 F	6.9
12/2/10	ND (0.2)	ND	ND	9
3/15/11	ND	ND	ND	9.8
6/24/11	ND (0.2)	ND	ND	8.5
Q3 2011	NS	NS	NS	NS
1/11/12	ND (0.2)	ND	0.02	9.9
3/27/12	ND (0.2)	2	2.2	9
6/25/12	ND (0.2)	2	2.19	9.8
8/16/12	ND (0.45)	1.8	2	9.2

WCSW-02				
Date	Benzene	TAH	TAqH	TCE
3/26/09	ND(0.12)	ND	ND	0.36 F
4/20/09	ND(0.12)	ND	0.01 J	0.42 F
4/27/09	ND(0.12)	ND	0.02 F	ND(0.22)
5/4/09	ND(0.12)	ND	ND	ND(0.22)
5/11/09	ND(0.12)	ND	ND	ND(0.22)
5/26/09	ND(0.12)	ND	ND	ND(0.22)
6/2/09	ND(0.12)	ND	ND	ND(0.22)
6/8/09	ND(0.12)	ND	0.21 F	ND(0.22)
6/22/09	ND(0.12)	ND	ND	ND(0.22)
7/6/09	ND(0.12)	ND	0.29 J	ND(0.22)
7/20/09	ND(0.12)	ND	0.43 F	0.59 F
8/3/09	ND(0.12)	ND	0.02 F	0.32 F
8/10/09	ND(0.12)	ND	0.03 F	ND(0.22)
8/17/09	ND(0.12)	ND	0.28 F	0.35 F
8/24/09	ND(0.12)	ND	0.28 J	ND(0.22)
9/22/14	ND(0.2)	ND	ND	ND(0.2)
9/25/09	ND(0.2)	ND	ND	0.30 F
10/5/09	ND(0.2)	0.25 F	0.25 F	ND(0.2)
10/19/09	ND(0.2)	0.23 F	0.82	0.36 F
10/19/09	ND(0.2)	ND	0.12 F	1.5
11/16/09	ND(0.2)	0.23 F	0.23 F	0.36 F
12/14/09	ND(0.2)	0.33 F	0.33 F	1.3
1/19/10	ND (0.2)	0.51 F	0.51 F	0.31 F
2/16/10	ND (0.2)	ND	ND	0.34 F
3/15/10	ND (0.2)	ND	ND	0.25 F
3/15/10	ND (0.2)	ND	ND	0.23 F
5/3/10	ND (0.2)	ND	0.13 F	ND (0.2)
6/5/10	ND (0.2)	ND		ND (0.2)
9/8/10	ND (0.2)	0.44 F	0.44 F	ND (0.2)
12/2/10	ND (0.2)	ND	0.19	0.36 F
12/2/10	ND (0.2)	ND	ND	0.41 F
3/15/11	ND	ND	ND	0.59 F
6/24/11	ND (0.2)	ND	0.2552	0.40 U
9/23/11	ND (0.2)	ND	0.0179 J	0.15 J
1/11/12	ND (0.2)	ND	0.07	0.79 J
3/27/12	ND (0.2)	1.9	2.2	ND (0.4)
6/25/12	ND (0.2)	1.93	2.11	ND (0.4)
8/16/12	ND (0.45)	2.2	2	0.55 B

OU5SP-03				
Date	Benzene	TAH	TAqH	TCE
8/12/03	NS	NS	NS	0.67
7/14/04	NS	NS	NS	0.8
1/26/05	NS	NS	NS	0.93
7/26/06	NS	NS	NS	1.2
4/23/07	NS	NS	NS	1.5
6/2/09	0.65	0.65	0.68	1.2
6/5/10	0.7	0.7	0.7	1.2
8/16/12	0.49 J	1.84	2.12	1.5

Image Source: Aero-Metric, 2012



- Seep Sample Location
- Program Monitoring Well
- Non-Program Monitoring Well
- Abandoned Monitoring Well
- Surface Water Sample Location
- Estimated Groundwater Plume (Solvents)
- CERCLA Site
- Land Use Control Boundary
- JBER Boundary

Notes:
1. All groundwater results are in micrograms/liter [µg/L].
2. Red results exceed cleanup criteria.
3. Sediment samples units are in micrograms/kilogram [µg/Kg].

FLAGS:
F - Result in between the method detection limit and the reporting limit.
J - Analyte was positively identified, but result is estimated.
U - Not detected at the LOD.
B - The analyte was detected in the method blank or trip blank above LOD.

* Analyte Cleanup Criteria
Benzene [5 µg/L*]
TCE Trichloroethene [5 µg/L*]
TAH Total Aromatic Hydrocarbon [10 µg/L*]
TAqH Total Aqueous Hydrocarbon [15 µg/L*]
ND = Not Detected (Detection Limit)
NS = Not Sampled

N

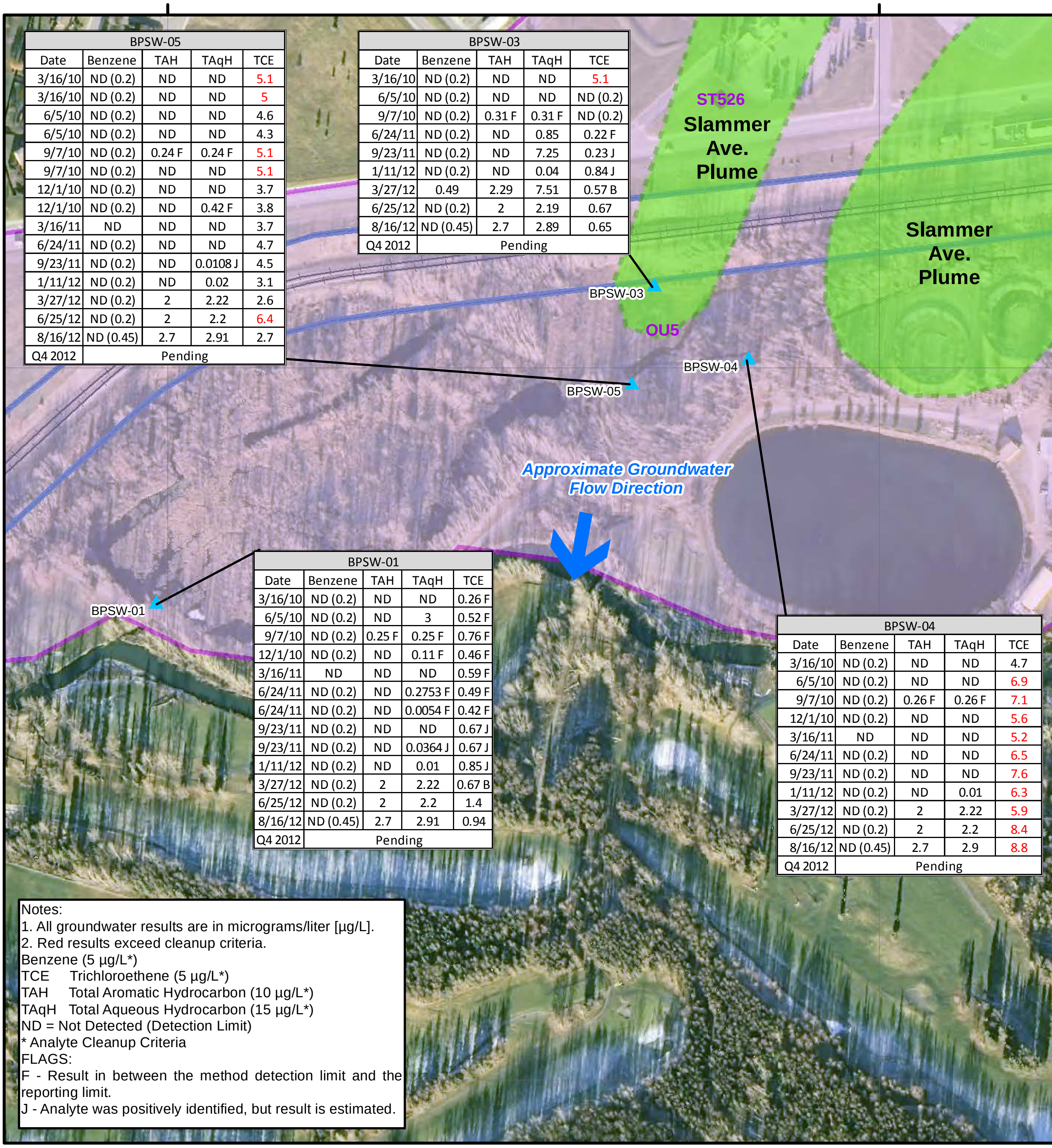
All Locations Are Approximate
0 75 150 225 300
Feet
WGS 1984 UTM Zone 6N

SEEP AND SURFACE WATER SITE MAP AND HISTORICAL DATA AT THE WETLAND REMEDIATION SYSTEM

JOINT BASE ELMENDORF-RICHARDSON, ALASKA

JACOBS | DATE: 11 MAR 2014 | PROJECT MANAGER: K. MAHER | FIGURE NO: C-14

P:\JBERAFCEE-08\TO142_FiveYearReview\MXD\Elmendorf5Yr_2013\SeepAndSurfaceWaterSiteMapWetlandTreatmentCellRegion.mxd beatyc



BPSW-05				
Date	Benzene	TAH	TAqH	TCE
3/16/10	ND (0.2)	ND	ND	5.1
3/16/10	ND (0.2)	ND	ND	5
6/5/10	ND (0.2)	ND	ND	4.6
6/5/10	ND (0.2)	ND	ND	4.3
9/7/10	ND (0.2)	0.24 F	0.24 F	5.1
9/7/10	ND (0.2)	ND	ND	5.1
12/1/10	ND (0.2)	ND	ND	3.7
12/1/10	ND (0.2)	ND	0.42 F	3.8
3/16/11	ND	ND	ND	3.7
6/24/11	ND (0.2)	ND	ND	4.7
9/23/11	ND (0.2)	ND	0.0108 J	4.5
1/11/12	ND (0.2)	ND	0.02	3.1
3/27/12	ND (0.2)	2	2.22	2.6
6/25/12	ND (0.2)	2	2.2	6.4
8/16/12	ND (0.45)	2.7	2.91	2.7
Q4 2012	Pending			

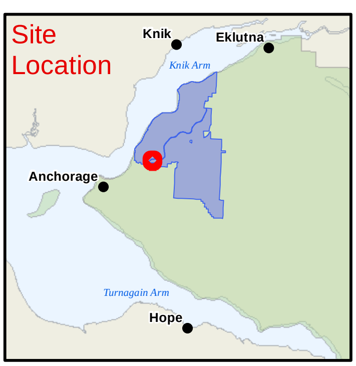
BPSW-03				
Date	Benzene	TAH	TAqH	TCE
3/16/10	ND (0.2)	ND	ND	5.1
6/5/10	ND (0.2)	ND	ND	ND (0.2)
9/7/10	ND (0.2)	0.31 F	0.31 F	ND (0.2)
6/24/11	ND (0.2)	ND	0.85	0.22 F
9/23/11	ND (0.2)	ND	7.25	0.23 J
1/11/12	ND (0.2)	ND	0.04	0.84 J
3/27/12	0.49	2.29	7.51	0.57 B
6/25/12	ND (0.2)	2	2.19	0.67
8/16/12	ND (0.45)	2.7	2.89	0.65
Q4 2012	Pending			

BPSW-01				
Date	Benzene	TAH	TAqH	TCE
3/16/10	ND (0.2)	ND	ND	0.26 F
6/5/10	ND (0.2)	ND	3	0.52 F
9/7/10	ND (0.2)	0.25 F	0.25 F	0.76 F
12/1/10	ND (0.2)	ND	0.11 F	0.46 F
3/16/11	ND	ND	ND	0.59 F
6/24/11	ND (0.2)	ND	0.2753 F	0.49 F
6/24/11	ND (0.2)	ND	0.0054 F	0.42 F
9/23/11	ND (0.2)	ND	ND	0.67 J
9/23/11	ND (0.2)	ND	0.0364 J	0.67 J
1/11/12	ND (0.2)	ND	0.01	0.85 J
3/27/12	ND (0.2)	2	2.22	0.67 B
6/25/12	ND (0.2)	2	2.2	1.4
8/16/12	ND (0.45)	2.7	2.91	0.94
Q4 2012	Pending			

BPSW-04				
Date	Benzene	TAH	TAqH	TCE
3/16/10	ND (0.2)	ND	ND	4.7
6/5/10	ND (0.2)	ND	ND	6.9
9/7/10	ND (0.2)	0.26 F	0.26 F	7.1
12/1/10	ND (0.2)	ND	ND	5.6
3/16/11	ND	ND	ND	5.2
6/24/11	ND (0.2)	ND	ND	6.5
9/23/11	ND (0.2)	ND	ND	7.6
1/11/12	ND (0.2)	ND	0.01	6.3
3/27/12	ND (0.2)	2	2.22	5.9
6/25/12	ND (0.2)	2	2.2	8.4
8/16/12	ND (0.45)	2.7	2.9	8.8
Q4 2012	Pending			

Notes:
1. All groundwater results are in micrograms/liter [µg/L].
2. Red results exceed cleanup criteria.
Benzene (5 µg/L*)
TCE Trichloroethene (5 µg/L*)
TAH Total Aromatic Hydrocarbon (10 µg/L*)
TAqH Total Aqueous Hydrocarbon (15 µg/L*)
ND = Not Detected (Detection Limit)
* Analyte Cleanup Criteria
FLAGS:
F - Result in between the method detection limit and the reporting limit.
J - Analyte was positively identified, but result is estimated.

Image Source: Aero-Metric, 2012



Surface Water Sample Location
Estimated Groundwater Plume (Solvents)
Land Use Control Boundary
JBER Boundary

All Locations Are Approximate
0 100 200 300 400
Feet
WGS 1984 UTM Zone 6N

N

SURFACE WATER SITE MAP
AND HISTORICAL DATA
BEAVER POND AREA

JOINT BASE ELMENDORF-RICHARDSON, ALASKA

JACOBS	DATE: 07 MAR 2014	PROJECT MANAGER: K. MAHER	FIGURE NO: C-15

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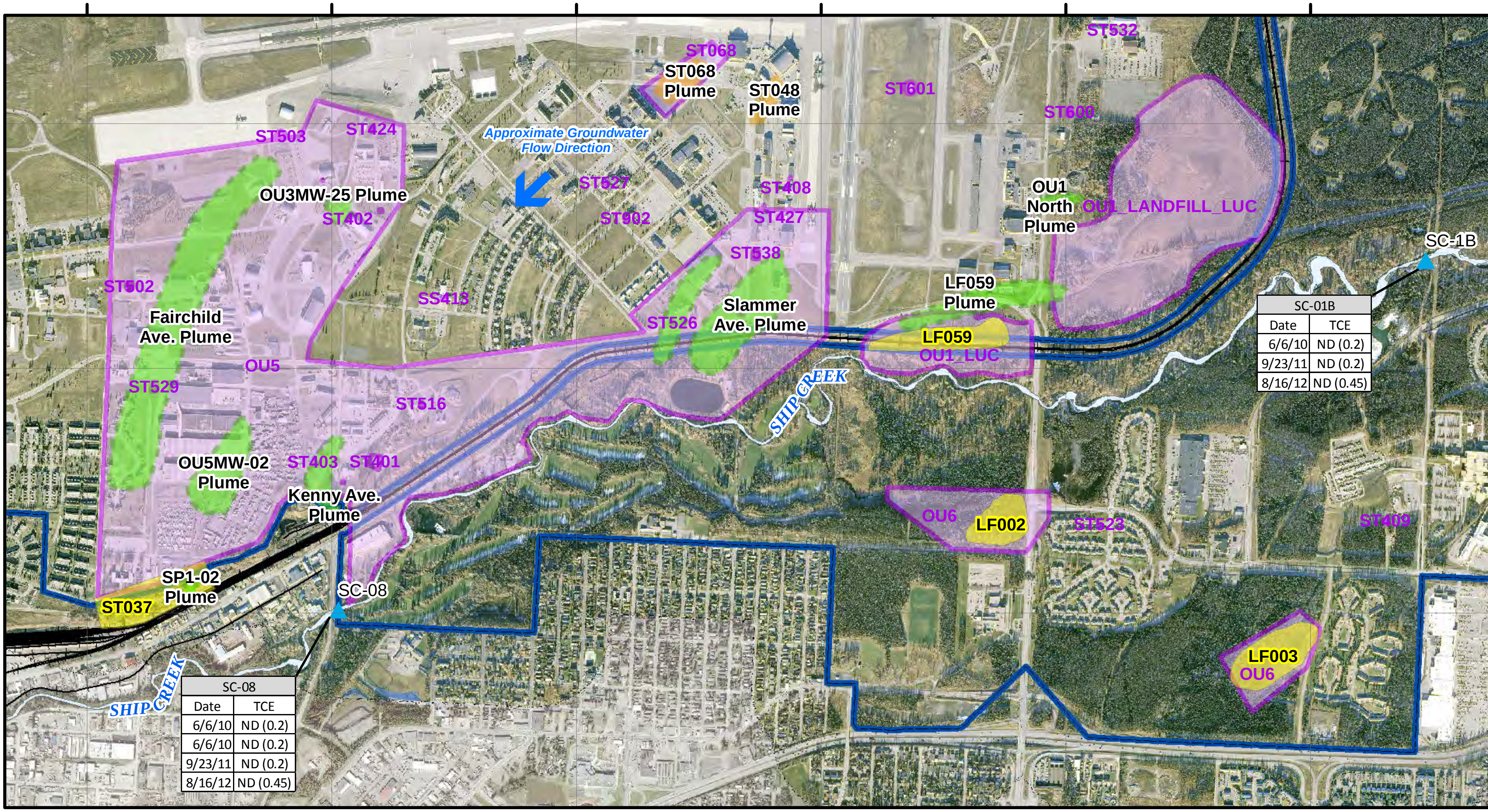
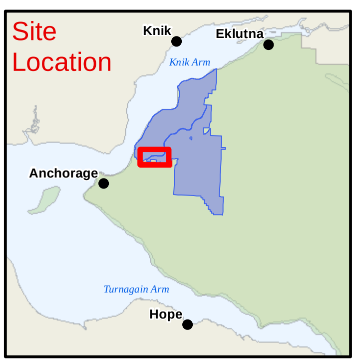


SC-08

Date	TCE
6/6/10	ND (0.2)
6/6/10	ND (0.2)
9/23/11	ND (0.2)
8/16/12	ND (0.45)

SC-01B

Date	TCE
6/6/10	ND (0.2)
9/23/11	ND (0.2)
8/16/12	ND (0.45)



Surface Water Sample Location
Estimated Groundwater Plume (Solvents)
Inferred Groundwater Plume (Fuels)
CERCLA Site Boundary
Land Use Control Boundary
JBER Boundary

Notes:
1. All groundwater results are in micrograms/liter [µg/L].
2. Red results exceed cleanup criteria.

TCE = Trichloroethene (5 µg/L*)
ND = Not Detected (Detection Limit)

N

All Locations Are Approximate

0 1,000 2,000 3,000 4,000
Feet

WGS 1984 UTM Zone 6N

SHIP CREEK SITE MAP AND HISTORICAL DATA

JOINT BASE ELMENDORF-RICHARDSON, ALASKA

JACOBS | DATE: 07 MAR 2014 | PROJECT MANAGER: K. MAHER | FIGURE NO: C-16

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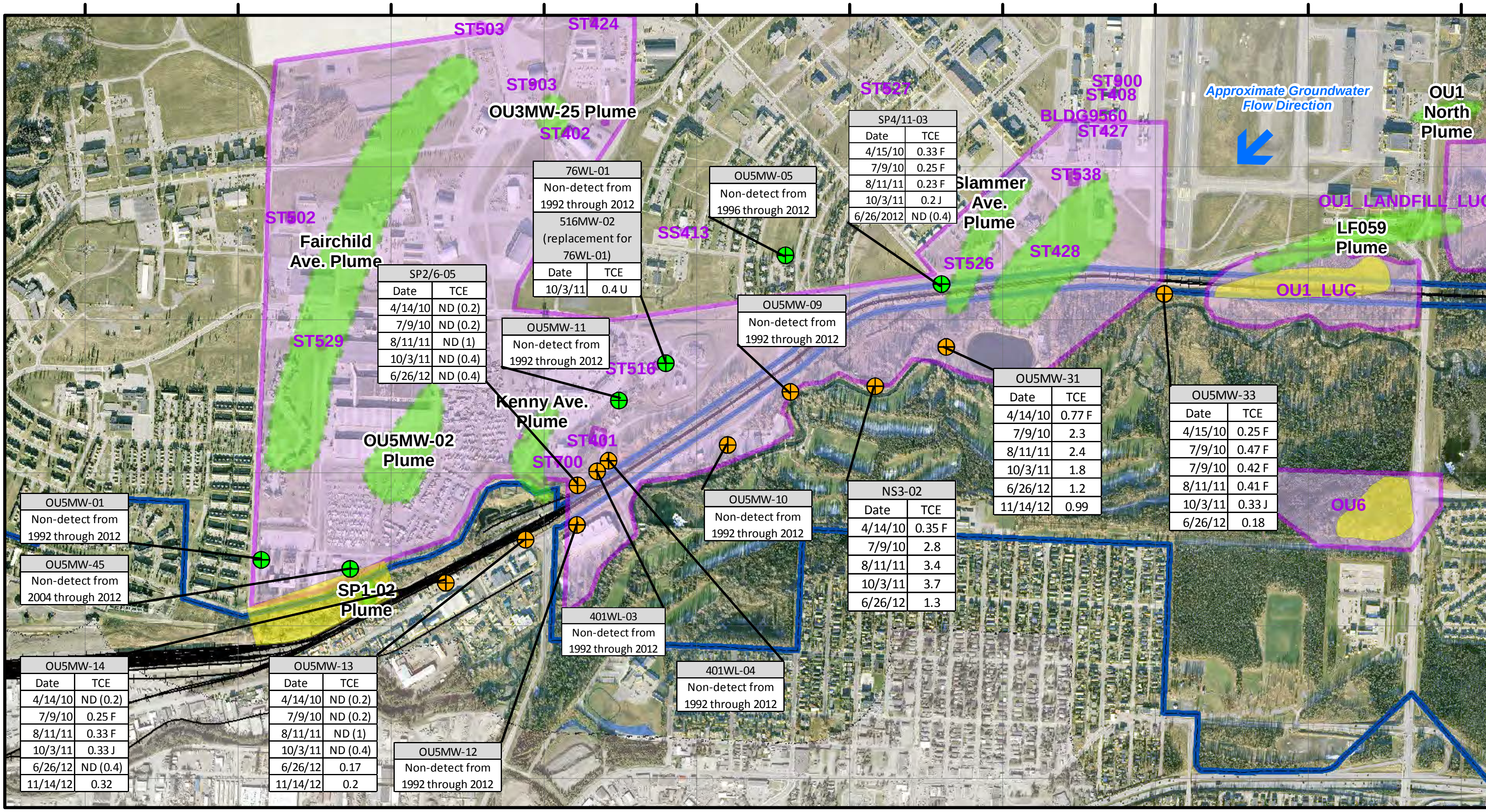


Image Source: Aero-Metric, 2009 & 2012

- Early Warning Wells
- Sentry Wells
- Estimated Groundwater Plume (Solvents)
- Inferred Groundwater Plume (Fuels)
- CERCLA Site Boundary
- Land Use Control Boundary
- JBER Boundary

Notes:
1. All groundwater results are in micrograms/liter [µg/L].
2. Red results exceed cleanup criteria.
TCE Trichloroethene (5ug/L*)
ND = Not Detected (Detection Limit)
* Analyte Cleanup Criteria

N

All Locations Are Approximate

0 500 1,000 1,500 2,000
Feet

WGS 1984 UTM Zone 6N

Flags:
F - Result is between the method detection limit and the reporting limit.
J - Analyte was positively identified, but the result is estimated.
U - Not detected at the LOD.

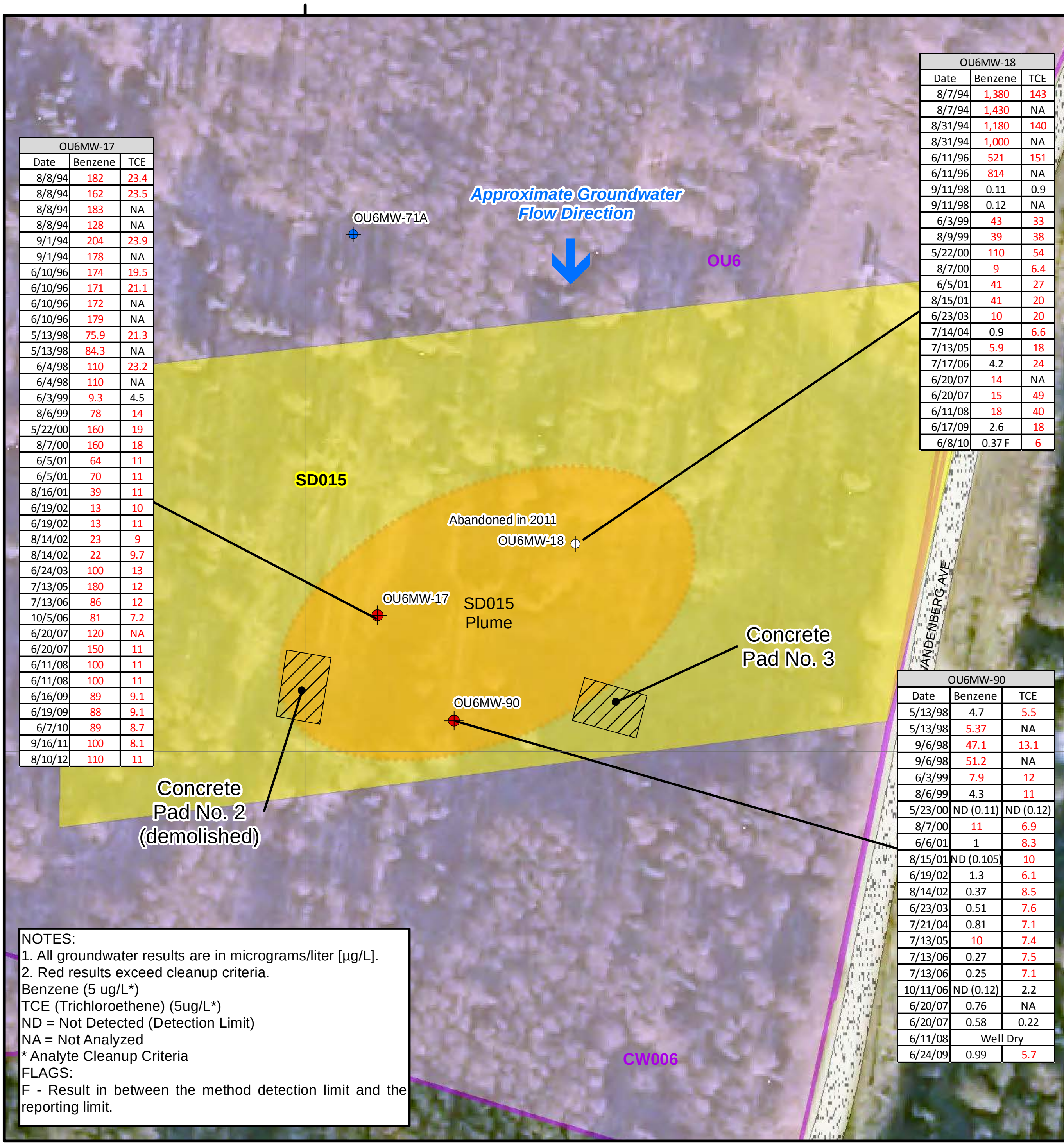
EARLY WARNING AND SENTRY WELLS
MONITORING SITE MAP

JOINT BASE ELMENDORF-RICHARDSON, ALASKA

JACOBS

DATE:	PROJECT MANAGER:	FIGURE NO:
07 MAR 2014	K. MAHER	C-17

P:\JBER\AFCEE-08\TO142_FiveYearReview\MXD\Elmendorf5Yr_2013\EarlyWarningAndSentryWells.mxd beatycj



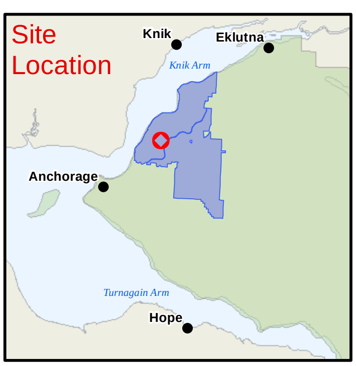
OU6MW-17		
Date	Benzene	TCE
8/8/94	182	23.4
8/8/94	162	23.5
8/8/94	183	NA
8/8/94	128	NA
9/1/94	204	23.9
9/1/94	178	NA
6/10/96	174	19.5
6/10/96	171	21.1
6/10/96	172	NA
6/10/96	179	NA
5/13/98	75.9	21.3
5/13/98	84.3	NA
6/4/98	110	23.2
6/4/98	110	NA
6/3/99	9.3	4.5
8/6/99	78	14
5/22/00	160	19
8/7/00	160	18
6/5/01	64	11
6/5/01	70	11
8/16/01	39	11
6/19/02	13	10
6/19/02	13	11
8/14/02	23	9
8/14/02	22	9.7
6/24/03	100	13
7/13/05	180	12
7/13/06	86	12
10/5/06	81	7.2
6/20/07	120	NA
6/20/07	150	11
6/11/08	100	11
6/11/08	100	11
6/16/09	89	9.1
6/19/09	88	9.1
6/7/10	89	8.7
9/16/11	100	8.1
8/10/12	110	11

OU6MW-18		
Date	Benzene	TCE
8/7/94	1,380	143
8/7/94	1,430	NA
8/31/94	1,180	140
8/31/94	1,000	NA
6/11/96	521	151
6/11/96	814	NA
9/11/98	0.11	0.9
9/11/98	0.12	NA
6/3/99	43	33
8/9/99	39	38
5/22/00	110	54
8/7/00	9	6.4
6/5/01	41	27
8/15/01	41	20
6/23/03	10	20
7/14/04	0.9	6.6
7/13/05	5.9	18
7/17/06	4.2	24
6/20/07	14	NA
6/20/07	15	49
6/11/08	18	40
6/17/09	2.6	18
6/8/10	0.37 F	6

OU6MW-90		
Date	Benzene	TCE
5/13/98	4.7	5.5
5/13/98	5.37	NA
9/6/98	47.1	13.1
9/6/98	51.2	NA
6/3/99	7.9	12
8/6/99	4.3	11
5/23/00	ND (0.11)	ND (0.12)
8/7/00	11	6.9
6/6/01	1	8.3
8/15/01	ND (0.105)	10
6/19/02	1.3	6.1
8/14/02	0.37	8.5
6/23/03	0.51	7.6
7/21/04	0.81	7.1
7/13/05	10	7.4
7/13/06	0.27	7.5
7/13/06	0.25	7.1
10/11/06	ND (0.12)	2.2
6/20/07	0.76	NA
6/20/07	0.58	0.22
6/11/08	Well Dry	
6/24/09	0.99	5.7

NOTES:
1. All groundwater results are in micrograms/liter [µg/L].
2. Red results exceed cleanup criteria.
Benzene (5 ug/L*)
TCE (Trichloroethene) (5ug/L*)
ND = Not Detected (Detection Limit)
NA = Not Analyzed
* Analyte Cleanup Criteria
FLAGS:
F - Result in between the method detection limit and the reporting limit.

Image Source: Aero-Metric, 2012



Program Monitoring Well
Non-Program Monitoring Well
Abandoned Monitoring Well
Source Area (Approximate)
Inferred Plume Boundary (Fuels)
CERCLA Site Boundary
Land Use Control Boundary

All Locations Are Approximate
0 50 100 150 200
Feet
WGS 1984 UTM Zone 6N

N

SD015 SITE MAP AND HISTORICAL DATA

JOINT BASE ELMENDORF-RICHARDSON, ALASKA

JACOBS	DATE: 11 MAR 2014	PROJECT MANAGER: K. MAHER	FIGURE NO: C-18

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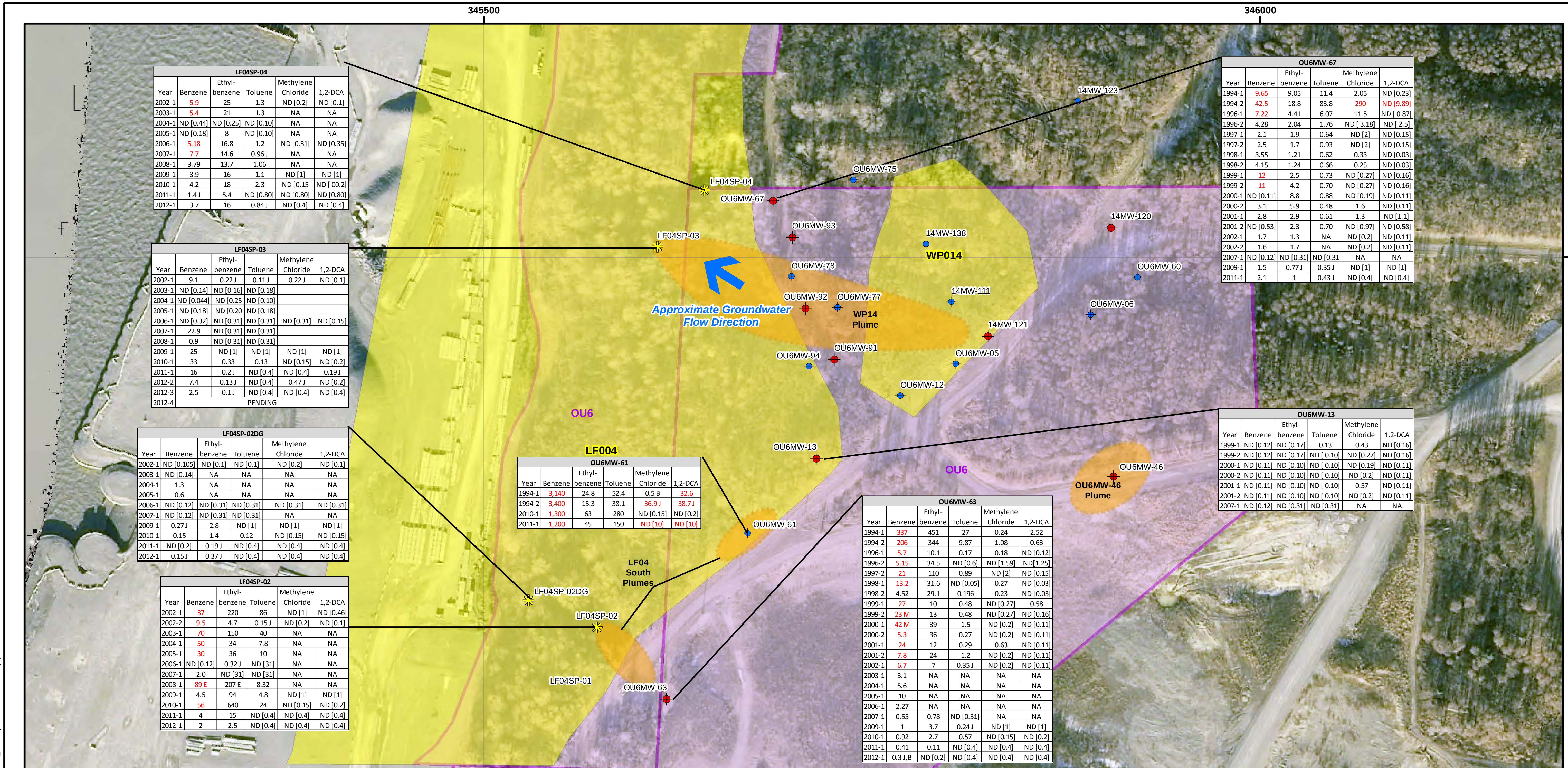


LF04SP-04					
Year	Benzene	Ethyl-benzene	Toluene	Methylene Chloride	1,2-DCA
2002-1	5.9	25	1.3	ND [0.2]	ND [0.1]
2003-1	5.4	21	1.3	NA	NA
2004-1	ND [0.44]	ND [0.25]	ND [0.10]	NA	NA
2005-1	ND [0.18]	8	ND [0.10]	NA	NA
2006-1	5.18	16.8	1.2	ND [0.31]	ND [0.35]
2007-1	7.7	14.6	0.96 J	NA	NA
2008-1	3.79	13.7	1.06	NA	NA
2009-1	3.9	16	1.1	ND [1]	ND [1]
2010-1	4.2	18	2.3	ND [0.15	ND [00.2]
2011-1	1.4 J	5.4	ND [0.80]	ND [0.80]	ND [0.80]
2012-1	3.7	16	0.84 J	ND [0.4]	ND [0.4]

LF04SP-03					
Year	Benzene	Ethyl-benzene	Toluene	Methylene Chloride	1,2-DCA
2002-1	9.1	0.22 J	0.11 J	0.22 J	ND [0.1]
2003-1	ND [0.14]	ND [0.16]	ND [0.18]		
2004-1	ND [0.044]	ND [0.25	ND [0.10]		
2005-1	ND [0.18]	ND [0.20	ND [0.18]		
2006-1	ND [0.32]	ND [0.31]	ND [0.31]	ND [0.31]	ND [0.15]
2007-1	22.9	ND [0.31]	ND [0.31]		
2008-1	0.9	ND [0.31]	ND [0.31]		
2009-1	25	ND [1]	ND [1]	ND [1]	ND [1]
2010-1	33	0.33	0.13	ND [0.15]	ND [0.2]
2011-1	16	0.2 J	ND [0.4]	ND [0.4]	0.19 J
2012-2	7.4	0.13 J	ND [0.4]	0.47 J	ND [0.2]
2012-3	2.5	0.1 J	ND [0.4]	ND [0.4]	ND [0.4]
2012-4	PENDING				

LF04SP-02DG					
Year	Benzene	Ethyl-benzene	Toluene	Methylene Chloride	1,2-DCA
2002-1	ND [0.105]	ND [0.1]	ND [0.1]	ND [0.2]	ND [0.1]
2003-1	ND [0.14]	NA	NA	NA	NA
2004-1	1.3	NA	NA	NA	NA
2005-1	0.6	NA	NA	NA	NA
2006-1	ND [0.12]	ND [0.31]	ND [0.31]	ND [0.31]	ND [0.31]
2007-1	ND [0.12]	ND [0.31]	ND [0.31]	NA	NA
2009-1	0.27 J	2.8	ND [1]	ND [1]	ND [1]
2010-1	0.15	1.4	0.12	ND [0.15]	ND [0.15]
2011-1	ND [0.2]	0.19 J	ND [0.4]	ND [0.4]	ND [0.4]
2012-1	0.15 J	0.37 J	ND [0.4]	ND [0.4]	ND [0.4]

LF04SP-02					
Year	Benzene	Ethyl-benzene	Toluene	Methylene Chloride	1,2-DCA
2002-1	37	220	86	ND [1]	ND [0.46]
2002-2	9.5	4.7	0.15 J	ND [0.2]	ND [0.1]
2003-1	70	150	40	NA	NA
2004-1	50	34	7.8	NA	NA
2005-1	30	36	10	NA	NA
2006-1	ND [0.12]	0.32 J	ND [31]	NA	NA
2007-1	2.0	ND [31]	ND [31]	NA	NA
2008-1	89 E	207 E	8.32	NA	NA
2009-1	4.5	94	4.8	ND [1]	ND [1]
2010-1	56	640	24	ND [0.15]	ND [0.2]
2011-1	4	15	ND [0.4]	ND [0.4]	ND [0.4]
2012-1	2	2.5	ND [0.4]	ND [0.4]	ND [0.4]

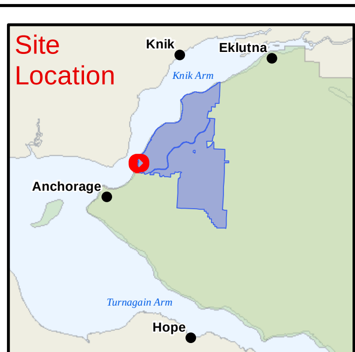
OU6MW-61					
Year	Benzene	Ethyl-benzene	Toluene	Methylene Chloride	1,2-DCA
1994-1	3,140	24.8	52.4	0.5 B	32.6
1994-2	3,400	15.3	38.1	36.9 J	38.7 J
2010-1	1,300	63	280	ND [0.15]	ND [0.2]
2011-1	1,200	45	150	ND [10]	ND [10]

OU6MW-63					
Year	Benzene	Ethyl-benzene	Toluene	Methylene Chloride	1,2-DCA
1994-1	337	451	27	0.24	2.52
1994-2	206	344	9.87	1.08	0.63
1996-1	5.7	10.1	0.17	0.18	ND [0.12]
1996-2	5.15	34.5	ND [0.6]	ND [1.59]	ND[1.25]
1997-2	21	110	0.89	ND [2]	ND [0.15]
1998-1	13.2	31.6	ND [0.05]	0.27	ND [0.03]
1998-2	4.52	29.1	0.196	0.23	ND [0.03]
1999-1	27	10	0.48	ND [0.27]	0.58
1999-2	23 M	13	0.48	ND [0.27]	ND [0.16]
2000-1	42 M	39	1.5	ND [0.2]	ND [0.11]
2000-2	5.3	36	0.27	ND [0.2]	ND [0.11]
2001-1	24	12	0.29	0.63	ND [0.11]
2001-2	7.8	24	1.2	ND [0.2]	ND [0.11]
2002-1	6.7	7	0.35 J	ND [0.2]	ND [0.11]
2003-1	3.1	NA	NA	NA	NA
2004-1	5.6	NA	NA	NA	NA
2005-1	10	NA	NA	NA	NA
2006-1	2.27	NA	NA	NA	NA
2007-1	0.55	0.78	ND [0.31]	NA	NA
2009-1	1	3.7	0.24 J	ND [1]	ND [1]
2010-1	0.92	2.7	0.57	ND [0.15]	ND [0.2]
2011-1	0.41	0.11	ND [0.4]	ND [0.4]	ND [0.4]
2012-1	0.3 J,B	ND [0.2]	ND [0.4]	ND [0.4]	ND [0.4]

OU6MW-67					
Year	Benzene	Ethyl-benzene	Toluene	Methylene Chloride	1,2-DCA
1994-1	9.65	9.05	11.4	2.05	ND [0.23]
1994-2	42.5	18.8	83.8	290	ND [9.89]
1996-1	7.22	4.41	6.07	11.5	ND [0.87]
1996-2	4.28	2.04	1.76	ND [3.18]	ND [2.5]
1997-1	2.1	1.9	0.64	ND [2]	ND [0.15]
1997-2	2.5	1.7	0.93	ND [2]	ND [0.15]
1998-1	3.55	1.21	0.62	0.33	ND [0.03]
1998-2	4.15	1.24	0.66	0.25	ND [0.03]
1999-1	12	2.5	0.73	ND [0.27]	ND [0.16]
1999-2	11	4.2	0.70	ND [0.27]	ND [0.16]
2000-1	ND [0.11]	8.8	0.88	ND [0.19]	ND [0.11]
2000-2	3.1	5.9	0.48	1.6	ND [0.11]
2001-1	2.8	2.9	0.61	1.3	ND [1.1]
2001-2	ND [0.53]	2.3	0.70	ND [0.97]	ND [0.58]
2002-1	1.7	1.3	NA	ND [0.2]	ND [0.11]
2002-2	1.6	1.7	NA	ND [0.2]	ND [0.11]
2007-1	ND [0.12]	ND [0.31]	ND [0.31	NA	NA
2009-1	1.5	0.77 J	0.35 J	ND [1]	ND [1]
2011-1	2.1	1	0.43 J	ND [0.4]	ND [0.4]

OU6MW-13					
Year	Benzene	Ethyl-benzene	Toluene	Methylene Chloride	1,2-DCA
1999-1	ND [0.12]	ND [0.17]	0.13	0.43	ND [0.16]
1999-2	ND [0.12]	ND [0.17]	ND [0.10]	ND [0.27]	ND [0.16]
2000-1	ND [0.11]	ND [0.10]	ND [0.10]	ND [0.19]	ND [0.11]
2000-2	ND [0.11]	ND [0.10]	ND [0.10]	ND [0.2]	ND [0.11]
2001-1	ND [0.11]	ND [0.10]	ND [0.10]	0.57	ND [0.11]
2001-2	ND [0.11]	ND [0.10]	ND [0.10]	ND [0.2]	ND [0.11]
2007-1	ND [0.12]	ND [0.31]	ND [0.31]	NA	NA

Image Source: Aero-Metric, 2012



- Seep Sample Location
- Program Monitoring Well
- Non-Program Monitoring Well
- Abandoned Monitoring Well
- Inferred Plume Boundary (Fuels)
- **CERCLA Site Boundary**
- **Land Use Control Boundary**

NOTES:
1. All groundwater results are in micrograms per liter (ug/L).
2. Red italicized results exceed cleanup criteria.

Benzene (5 ug/L*)
Ethylbenzene (700 ug/L*)
Toluene (1,000 ug/L*)
Metlylene Cloride (5 ug/L*)
1,2 - DCA (5 ug/L*)

ND Not Detected (brackets indicate the MDL for 2008 and earlier, the PQL for 2009, and the LOD for 2010 and 2011).
NA Not Analyzed
* Analyte Cleanup Criteria

FLAGS:
J - Analyte was positively identified, but result is estimated.

N

All Locations Are Approximate

0 100 200 300 400
Feet

WGS 1984 UTM Zone 6N

LF004 SOUTH SITE MAP
AND HISTORICAL DATA

JOINT BASE ELMENDORF-RICHARDSON, ALASKA

JACOBS

DATE:	PROJECT MANAGER:	FIGURE NO:
11 MAR 2014	K. MAHER	C-19

P:\JBER\AFCEE-08TO142_FiveYearReview\MXD\Elmendorf5Yr_2013\LF04_SiteMapAndWells.mxd beatyc

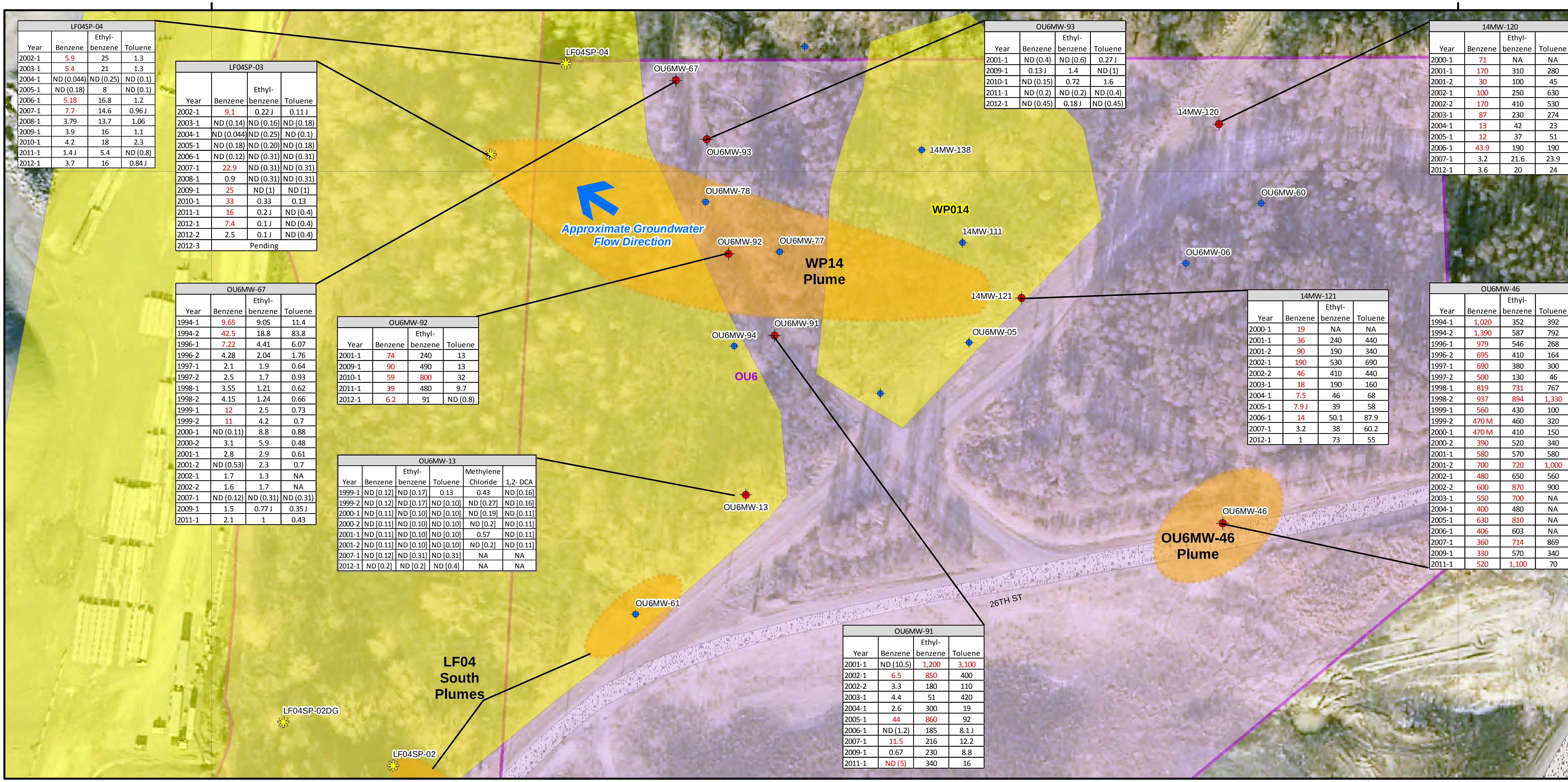


Image Source: Aero-Metric, 2012

LF04SP-04

Year	Benzene	Ethyl-benzene	Toluene
2002-1	5.9	25	1.3
2003-1	5.4	21	1.3
2004-1	ND (0.044)	ND (0.25)	ND (0.1)
2005-1	ND (0.18)	8	ND (0.1)
2006-1	5.18	16.8	1.2
2007-1	7.7	14.6	0.96 J
2008-1	3.79	13.7	1.06
2009-1	3.9	16	1.1
2010-1	4.2	18	2.3
2011-1	1.4 J	5.4	ND (0.8)
2012-1	3.7	16	0.84 J

LF04SP-03

Year	Benzene	Ethyl-benzene	Toluene
2002-1	9.1	0.22 J	0.11 J
2003-1	ND (0.14)	ND (0.16)	ND (0.18)
2004-1	ND (0.044)	ND (0.25)	ND (0.1)
2005-1	ND (0.18)	ND (0.20)	ND (0.18)
2006-1	ND (0.12)	ND (0.31)	ND (0.31)
2007-1	22.9	ND (0.31)	ND (0.31)
2008-1	0.9	ND (0.31)	ND (0.31)
2009-1	25	ND (1)	ND (1)
2010-1	33	0.33	0.13
2011-1	16	0.2 J	ND (0.4)
2012-1	7.4	0.1 J	ND (0.4)
2012-2	2.5	0.1 J	ND (0.4)
2012-3	Pending		

OU6MW-93

Year	Benzene	Ethyl-benzene	Toluene
2001-1	ND (0.4)	ND (0.6)	0.27 J
2009-1	0.13 J	1.4	ND (1)
2010-1	ND (0.15)	0.72	1.6
2011-1	ND (0.2)	ND (0.2)	ND (0.4)
2012-1	ND (0.45)	0.18 J	ND (0.45)

14MW-120

Year	Benzene	Ethyl-benzene	Toluene
2000-1	71	NA	NA
2001-1	170	310	280
2001-2	30	100	45
2002-1	100	250	630
2002-2	170	410	530
2003-1	87	230	274
2004-1	13	42	23
2005-1	12	37	51
2006-1	43.9	190	190
2007-1	3.2	21.6	23.9
2012-1	3.6	20	24

OU6MW-67

Year	Benzene	Ethyl-benzene	Toluene
1994-1	9.65	9.05	11.4
1994-2	42.5	18.8	83.8
1996-1	7.22	4.41	6.07
1996-2	4.28	2.04	1.76
1997-1	2.1	1.9	0.64
1997-2	2.5	1.7	0.93
1998-1	3.55	1.21	0.62
1998-2	4.15	1.24	0.66
1999-1	12	2.5	0.73
1999-2	11	4.2	0.7
2000-1	ND (0.11)	8.8	0.88
2000-2	3.1	5.9	0.48
2001-1	2.8	2.9	0.61
2001-2	ND (0.53)	2.3	0.7
2002-1	1.7	1.3	NA
2002-2	1.6	1.7	NA
2007-1	ND (0.12)	ND (0.31)	ND (0.31)
2009-1	1.5	0.77 J	0.35 J
2011-1	2.1	1	0.43

OU6MW-92

Year	Benzene	Ethyl-benzene	Toluene
2001-1	74	240	13
2009-1	90	490	13
2010-1	59	800	32
2011-1	39	480	9.7
2012-1	6.2	91	ND (0.8)

14MW-121

Year	Benzene	Ethyl-benzene	Toluene
2000-1	19	NA	NA
2001-1	36	240	440
2001-2	90	190	340
2002-1	190	530	690
2002-2	46	410	440
2003-1	18	190	160
2004-1	7.5	46	68
2005-1	7.9 J	39	58
2006-1	14	50.1	87.9
2007-1	3.2	38	60.2
2012-1	1	73	55

OU6MW-46

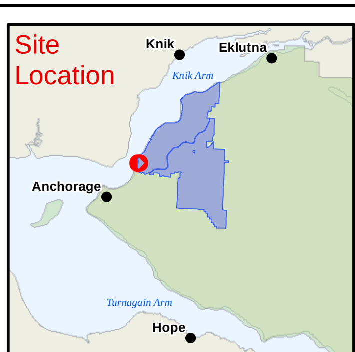
Year	Benzene	Ethyl-benzene	Toluene
1994-1	1,020	352	392
1994-2	1,390	587	792
1996-1	979	546	268
1996-2	695	410	164
1997-1	690	380	300
1997-2	500	130	46
1998-1	819	731	767
1998-2	937	894	1,330
1999-1	560	430	100
1999-2	470 M	460	320
2000-1	470 M	410	150
2000-2	390	520	340
2001-1	580	570	580
2001-2	700	720	1,000
2002-1	480	650	560
2002-2	600	870	900
2003-1	550	700	NA
2004-1	400	480	NA
2005-1	630	810	NA
2006-1	406	603	NA
2007-1	360	714	869
2009-1	330	570	340
2011-1	520	1,100	70

OU6MW-13

Year	Benzene	Ethyl-benzene	Toluene	Methylene Chloride	1,2- DCA
1999-1	ND [0.12]	ND [0.17]	0.13	0.43	ND [0.16]
1999-2	ND [0.12]	ND [0.17]	ND [0.10]	ND [0.27]	ND [0.16]
2000-1	ND [0.11]	ND [0.10]	ND [0.10]	ND [0.19]	ND [0.11]
2000-2	ND [0.11]	ND [0.10]	ND [0.10]	ND [0.2]	ND [0.11]
2001-1	ND [0.11]	ND [0.10]	ND [0.10]	0.57	ND [0.11]
2001-2	ND [0.11]	ND [0.10]	ND [0.10]	ND [0.2]	ND [0.11]
2007-1	ND [0.12]	ND [0.31]	ND [0.31]	NA	NA
2012-1	ND [0.2]	ND [0.2]	ND [0.4]	NA	NA

OU6MW-91

Year	Benzene	Ethyl-benzene	Toluene
2001-1	ND (10.5)	1,200	3,100
2002-1	6.5	850	400
2002-2	3.3	180	110
2003-1	4.4	51	420
2004-1	2.6	300	19
2005-1	44	860	92
2006-1	ND (1.2)	185	8.1 J
2007-1	11.5	216	12.2
2009-1	0.67	230	8.8
2011-1	ND (5)	340	16



Seep Sample Location
Program Monitoring Well
Non-Program Monitoring Well
Abandoned Monitoring Well
Inferred Plume Boundary (Fuels)
CERCLA Site Boundary
Land Use Control Boundary

NOTES:
1. All groundwater results are in micrograms per liter (ug/L).
2. Red italicized results exceed cleanup criteria.

Benzene (5 ug/L*)
Ethylbenzene (700 ug/L*)
Toluene (1,000 ug/L*)
ND Not Detected (brackets indicate the MDL for 2008 and earlier, the PQL for 2009, and the LOD for 2010 and 2011).
NA Not Analyzed
* Analyte Cleanup Criteria

FLAGS:
J - Analyte was positively identified, but result is estimated.

N

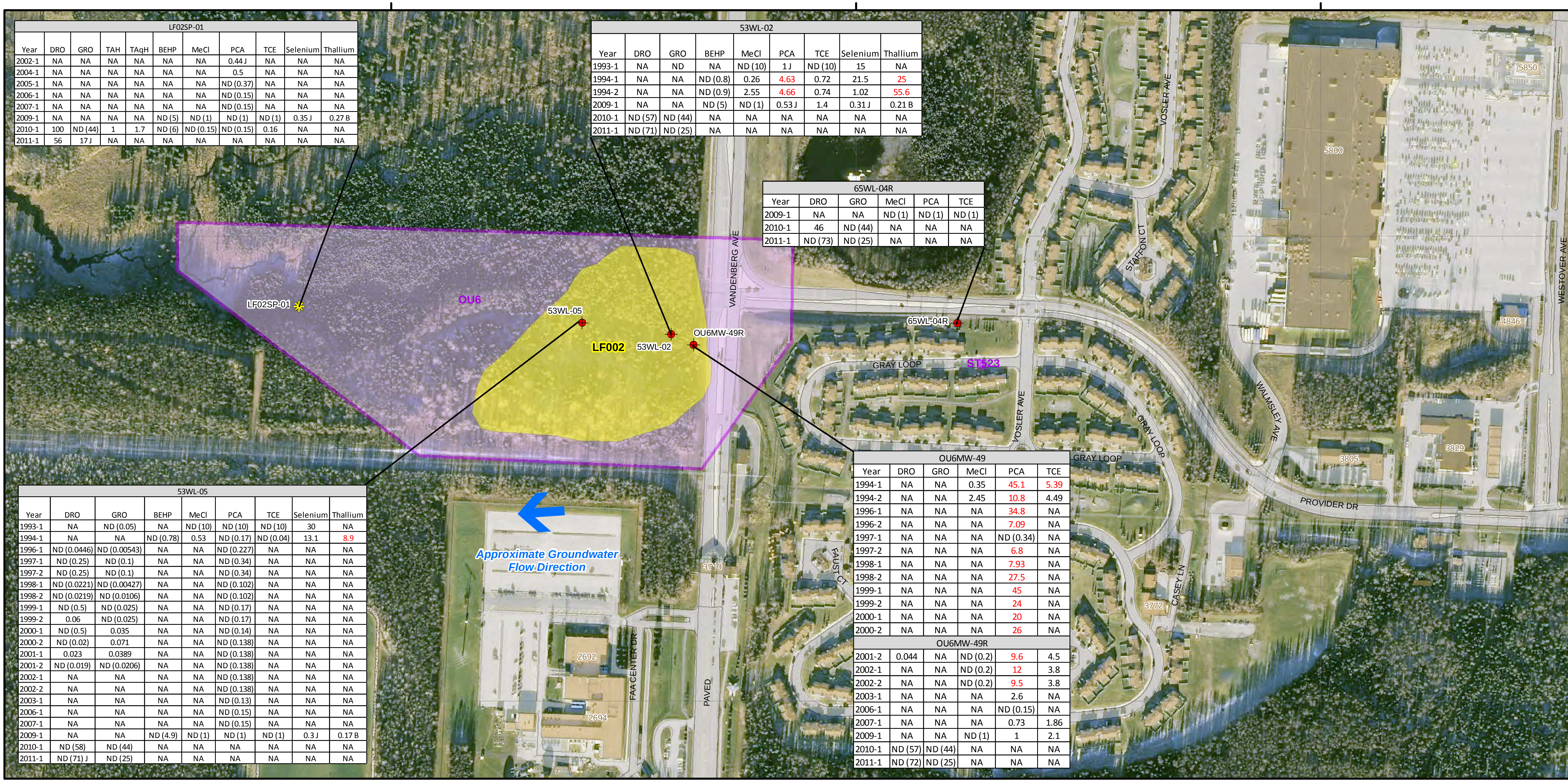
All Locations Are Approximate
0 50 100 150 200
Feet
WGS 1984 UTM Zone 6N

WP014 SITE MAP AND HISTORICAL DATA

JOINT BASE ELMENDORF-RICHARDSON, ALASKA

JACOBS	DATE: 11 MAR 2014	PROJECT MANAGER: K. MAHER	FIGURE NO: C-20

P:\JBERAFCEE-08TO142_FiveYearReview\MXD\Elmendorf5Yr_2013\WP14_SiteMapAndWells.mxd beatycj



LF02SP-01										
Year	DRO	GRO	TAH	TAqH	BEHP	MeCl	PCA	TCE	Selenium	Thallium
2002-1	NA	NA	NA	NA	NA	NA	0.44 J	NA	NA	NA
2004-1	NA	NA	NA	NA	NA	NA	0.5	NA	NA	NA
2005-1	NA	NA	NA	NA	NA	NA	ND (0.37)	NA	NA	NA
2006-1	NA	NA	NA	NA	NA	NA	ND (0.15)	NA	NA	NA
2007-1	NA	NA	NA	NA	NA	NA	ND (0.15)	NA	NA	NA
2009-1	NA	NA	NA	NA	ND (5)	ND (1)	ND (1)	ND (1)	0.35 J	0.27 B
2010-1	100	ND (44)	1	1.7	ND (6)	ND (0.15)	ND (0.15)	0.16	NA	NA
2011-1	56	17 J	NA	NA	NA	NA	NA	NA	NA	NA

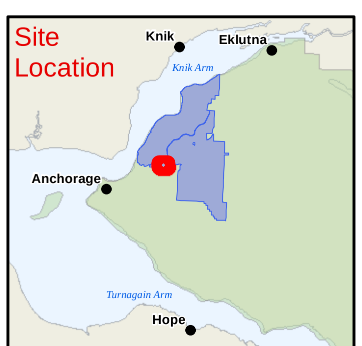
53WL-02								
Year	DRO	GRO	BEHP	MeCl	PCA	TCE	Selenium	Thallium
1993-1	NA	ND	NA	ND (10)	1 J	ND (10)	15	NA
1994-1	NA	NA	ND (0.8)	0.26	*4.63*	0.72	21.5	*25*
1994-2	NA	NA	ND (0.9)	2.55	*4.66*	0.74	1.02	*55.6*
2009-1	NA	NA	ND (5)	ND (1)	0.53 J	1.4	0.31 J	0.21 B
2010-1	ND (57)	ND (44)	NA	NA	NA	NA	NA	NA
2011-1	ND (71)	ND (25)	NA	NA	NA	NA	NA	NA

65WL-04R					
Year	DRO	GRO	MeCl	PCA	TCE
2009-1	NA	NA	ND (1)	ND (1)	ND (1)
2010-1	46	ND (44)	NA	NA	NA
2011-1	ND (73)	ND (25)	NA	NA	NA

53WL-05								
Year	DRO	GRO	BEHP	MeCl	PCA	TCE	Selenium	Thallium
1993-1	NA	ND (0.05)	NA	ND (10)	ND (10)	ND (10)	30	NA
1994-1	NA	NA	ND (0.78)	0.53	ND (0.17)	ND (0.04)	13.1	*8.9*
1996-1	ND (0.0446)	ND (0.00543)	NA	NA	ND (0.227)	NA	NA	NA
1997-1	ND (0.25)	ND (0.1)	NA	NA	ND (0.34)	NA	NA	NA
1997-2	ND (0.25)	ND (0.1)	NA	NA	ND (0.34)	NA	NA	NA
1998-1	ND (0.0221)	ND (0.00427)	NA	NA	ND (0.102)	NA	NA	NA
1998-2	ND (0.0219)	ND (0.0106)	NA	NA	ND (0.102)	NA	NA	NA
1999-1	ND (0.5)	ND (0.025)	NA	NA	ND (0.17)	NA	NA	NA
1999-2	0.06	ND (0.025)	NA	NA	ND (0.17)	NA	NA	NA
2000-1	ND (0.5)	0.035	NA	NA	ND (0.14)	NA	NA	NA
2000-2	ND (0.02)	0.071	NA	NA	ND (0.138)	NA	NA	NA
2001-1	0.023	0.0389	NA	NA	ND (0.138)	NA	NA	NA
2001-2	ND (0.019)	ND (0.0206)	NA	NA	ND (0.138)	NA	NA	NA
2002-1	NA	NA	NA	NA	ND (0.138)	NA	NA	NA
2002-2	NA	NA	NA	NA	ND (0.138)	NA	NA	NA
2003-1	NA	NA	NA	NA	ND (0.13)	NA	NA	NA
2006-1	NA	NA	NA	NA	ND (0.15)	NA	NA	NA
2007-1	NA	NA	NA	NA	ND (0.15)	NA	NA	NA
2009-1	NA	NA	ND (4.9)	ND (1)	ND (1)	ND (1)	0.3 J	0.17 B
2010-1	ND (58)	ND (44)	NA	NA	NA	NA	NA	NA
2011-1	ND (71) J	ND (25)	NA	NA	NA	NA	NA	NA

OU6MW-49					
Year	DRO	GRO	MeCl	PCA	TCE
1994-1	NA	NA	0.35	*45.1*	*5.39*
1994-2	NA	NA	2.45	*10.8*	4.49
1996-1	NA	NA	NA	*34.8*	NA
1996-2	NA	NA	NA	*7.09*	NA
1997-1	NA	NA	NA	ND (0.34)	NA
1997-2	NA	NA	NA	*6.8*	NA
1998-1	NA	NA	NA	*7.93*	NA
1998-2	NA	NA	NA	*27.5*	NA
1999-1	NA	NA	NA	*45*	NA
1999-2	NA	NA	NA	*24*	NA
2000-1	NA	NA	NA	*20*	NA
2000-2	NA	NA	NA	*26*	NA
OU6MW-49R					
2001-2	0.044	NA	ND (0.2)	*9.6*	4.5
2002-1	NA	NA	ND (0.2)	*12*	3.8
2002-2	NA	NA	ND (0.2)	*9.5*	3.8
2003-1	NA	NA	NA	2.6	NA
2006-1	NA	NA	NA	ND (0.15)	NA
2007-1	NA	NA	NA	0.73	1.86
2009-1	NA	NA	ND (1)	1	2.1
2010-1	ND (57)	ND (44)	NA	NA	NA
2011-1	ND (72)	ND (25)	NA	NA	NA

Image Source: Aero-Metric, 2012



Seep Sample Location
Program Monitoring Well
Non-Program Monitoring Well
Abandoned Monitoring Well
CERCLA Site Boundary
Land Use Control Boundary

NOTES:
1. All groundwater results are in micrograms per liter (ug/L).
2. Red italicized results exceed cleanup criteria.

FLAGS:
J - Analyte was positively identified, but result is estimated.
B - The analyte was detected in an associated blank sample, as well as in the sample at a concentration less than ten times the blank concentration.

ND Not Detected (brackets indicate the MDL for 2008 and earlier, the PQL for 2009, and the LOD for 2010 and 2011).
NA Not Analyzed
* Analyte Cleanup Criteria

Selenium (50 ug/L*)
Thallium (2 ug/L*)
DRO Diesel Range Organics (1,500 ug/L*)
GRO Gasoline Range Organics (2.200 ug/L*)
BEHP bis(2-ehthylexyl)pthlate (6 ug/L*)
MeCl Methylene Chloride (5 ug/L*)
PCA 1,1,2,2-tetrachloroethane (4 ug/L*)
TCE Trichloroethene (5 ug/L*)
TAH Total Aromatic Hydrocarbon (10 ug/L*)
TAqH Total Aqueous Hydrocarbon (15 ug/L*)

N

All Locations Are Approximate
0 250 500 750 1,000
Feet
WGS 1984 UTM Zone 6N

LF002 SITE MAP
AND HISTORICAL DATA

JOINT BASE ELMENDORF-RICHARDSON, ALASKA

JACOBS	DATE: 11 MAR 2014	PROJECT MANAGER: K. MAHER	FIGURE NO: C-21

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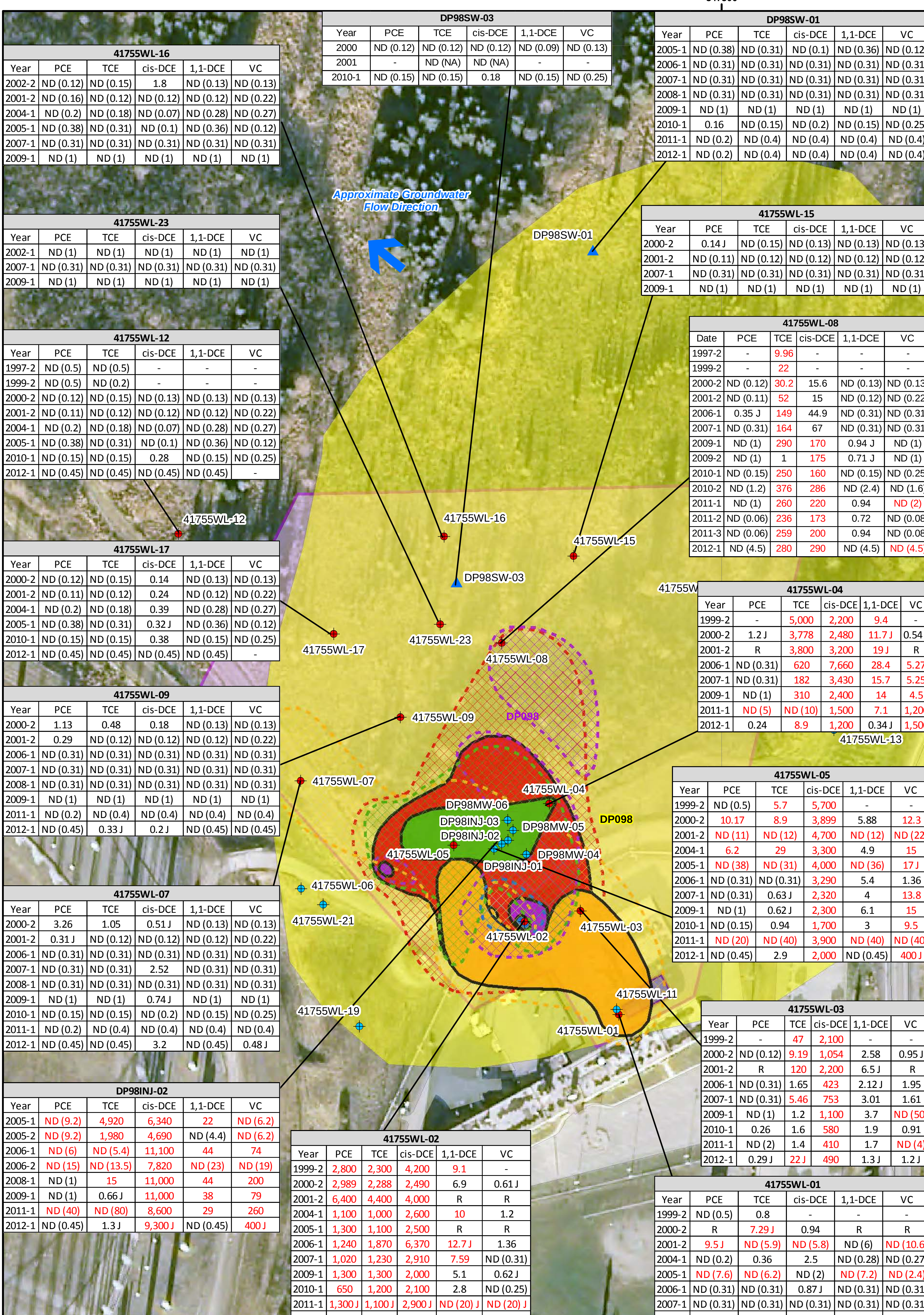


DP98SW-03

Year	PCE	TCE	cis-DCE	1,1-DCE	VC
2000	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.09)	ND (0.13)
2001	-	ND (NA)	ND (NA)	-	-
2010-1	ND (0.15)	ND (0.15)	0.18	ND (0.15)	ND (0.25)

DP98SW-01

Year	PCE	TCE	cis-DCE	1,1-DCE	VC
2005-1	ND (0.38)	ND (0.31)	ND (0.1)	ND (0.36)	ND (0.12)
2006-1	ND (0.31)	ND (0.31)	ND (0.31)	ND (0.31)	ND (0.31)
2007-1	ND (0.31)	ND (0.31)	ND (0.31)	ND (0.31)	ND (0.31)
2008-1	ND (0.31)	ND (0.31)	ND (0.31)	ND (0.31)	ND (0.31)
2009-1	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)
2010-1	0.16	ND (0.15)	ND (0.2)	ND (0.15)	ND (0.25)
2011-1	ND (0.2)	ND (0.4)	ND (0.4)	ND (0.4)	ND (0.4)
2012-1	ND (0.2)	ND (0.4)	ND (0.4)	ND (0.4)	ND (0.4)

41755WL-16

Year	PCE	TCE	cis-DCE	1,1-DCE	VC
2002-2	ND (0.12)	ND (0.15)	1.8	ND (0.13)	ND (0.13)
2001-2	ND (0.16)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.22)
2004-1	ND (0.2)	ND (0.18)	ND (0.07)	ND (0.28)	ND (0.27)
2005-1	ND (0.38)	ND (0.31)	ND (0.1)	ND (0.36)	ND (0.12)
2007-1	ND (0.31)	ND (0.31)	ND (0.31)	ND (0.31)	ND (0.31)
2009-1	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)

41755WL-23

Year	PCE	TCE	cis-DCE	1,1-DCE	VC
2002-1	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)
2007-1	ND (0.31)	ND (0.31)	ND (0.31)	ND (0.31)	ND (0.31)
2009-1	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)

41755WL-15

Year	PCE	TCE	cis-DCE	1,1-DCE	VC
2000-2	0.14 J	ND (0.15)	ND (0.13)	ND (0.13)	ND (0.13)
2001-2	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)
2007-1	ND (0.31)	ND (0.31)	ND (0.31)	ND (0.31)	ND (0.31)
2009-1	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)

41755WL-12

Year	PCE	TCE	cis-DCE	1,1-DCE	VC
1997-2	ND (0.5)	ND (0.5)	-	-	-
1999-2	ND (0.5)	ND (0.2)	-	-	-
2000-2	ND (0.12)	ND (0.15)	ND (0.13)	ND (0.13)	ND (0.13)
2001-2	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.22)
2004-1	ND (0.2)	ND (0.18)	ND (0.07)	ND (0.28)	ND (0.27)
2005-1	ND (0.38)	ND (0.31)	ND (0.1)	ND (0.36)	ND (0.12)
2010-1	ND (0.15)	ND (0.15)	0.28	ND (0.15)	ND (0.25)
2012-1	ND (0.45)	ND (0.45)	ND (0.45)	ND (0.45)	-

41755WL-08

Date	PCE	TCE	cis-DCE	1,1-DCE	VC
1997-2	-	9.96	-	-	-
1999-2	-	22	-	-	-
2000-2	ND (0.12)	30.2	15.6	ND (0.13)	ND (0.13)
2001-2	ND (0.11)	52	15	ND (0.12)	ND (0.22)
2006-1	0.35 J	149	44.9	ND (0.31)	ND (0.31)
2007-1	ND (0.31)	164	67	ND (0.31)	ND (0.31)
2009-1	ND (1)	290	170	0.94 J	ND (1)
2009-2	ND (1)	1	175	0.71 J	ND (1)
2010-1	ND (0.15)	250	160	ND (0.15)	ND (0.25)
2010-2	ND (1.2)	376	286	ND (2.4)	ND (1.6)
2011-1	ND (1)	260	220	0.94	ND (2)
2011-2	ND (0.06)	236	173	0.72	ND (0.08)
2011-3	ND (0.06)	259	200	0.94	ND (0.08)
2012-1	ND (4.5)	280	290	ND (4.5)	ND (4.5)

41755WL-17

Year	PCE	TCE	cis-DCE	1,1-DCE	VC
2000-2	ND (0.12)	ND (0.15)	0.14	ND (0.13)	ND (0.13)
2001-2	ND (0.11)	ND (0.12)	0.24	ND (0.12)	ND (0.22)
2004-1	ND (0.2)	ND (0.18)	0.39	ND (0.28)	ND (0.27)
2005-1	ND (0.38)	ND (0.31)	0.32 J	ND (0.36)	ND (0.12)
2010-1	ND (0.15)	ND (0.15)	0.38	ND (0.15)	ND (0.25)
2012-1	ND (0.45)	ND (0.45)	ND (0.45)	ND (0.45)	-

41755WL-04

Year	PCE	TCE	cis-DCE	1,1-DCE	VC
1999-2	-	5,000	2,200	9.4	-
2000-2	1.2 J	3,778	2,480	11.7 J	0.54 J
2001-2	R	3,800	3,200	19 J	R
2006-1	ND (0.31)	620	7,660	28.4	5.27
2007-1	ND (0.31)	182	3,430	15.7	5.25
2009-1	ND (1)	310	2,400	14	4.5
2011-1	ND (5)	ND (10)	1,500	7.1	1,200
2012-1	0.24	8.9	1,200	0.34 J	1,500

41755WL-09

Year	PCE	TCE	cis-DCE	1,1-DCE	VC
2000-2	1.13	0.48	0.18	ND (0.13)	ND (0.13)
2001-2	0.29	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.22)
2006-1	ND (0.31)	ND (0.31)	ND (0.31)	ND (0.31)	ND (0.31)
2007-1	ND (0.31)	ND (0.31)	ND (0.31)	ND (0.31)	ND (0.31)
2008-1	ND (0.31)	ND (0.31)	ND (0.31)	ND (0.31)	ND (0.31)
2009-1	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)
2011-1	ND (0.2)	ND (0.4)	ND (0.4)	ND (0.4)	ND (0.4)
2012-1	ND (0.45)	0.33 J	0.2 J	ND (0.45)	ND (0.45)

41755WL-05

Year	PCE	TCE	cis-DCE	1,1-DCE	VC
1999-2	ND (0.5)	5.7	5,700	-	-
2000-2	10.17	8.9	3,899	5.88	12.3
2001-2	ND (11)	ND (12)	4,700	ND (12)	ND (22)
2004-1	6.2	29	3,300	4.9	15
2005-1	ND (38)	ND (31)	4,000	ND (36)	17 J
2006-1	ND (0.31)	ND (0.31)	3,290	5.4	1.36
2007-1	ND (0.31)	0.63 J	2,320	4	13.8
2009-1	ND (1)	0.62 J	2,300	6.1	15
2010-1	ND (0.15)	0.94	1,700	3	9.5
2011-1	ND (20)	ND (40)	3,900	ND (40)	ND (40)
2012-1	ND (0.45)	2.9	2,000	ND (0.45)	400 J

41755WL-07

Year	PCE	TCE	cis-DCE	1,1-DCE	VC
2000-2	3.26	1.05	0.51 J	ND (0.13)	ND (0.13)
2001-2	0.31 J	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.22)
2006-1	ND (0.31)	ND (0.31)	ND (0.31)	ND (0.31)	ND (0.31)
2007-1	ND (0.31)	ND (0.31)	2.52	ND (0.31)	ND (0.31)
2008-1	ND (0.31)	ND (0.31)	ND (0.31)	ND (0.31)	ND (0.31)
2009-1	ND (1)	ND (1)	0.74 J	ND (1)	ND (1)
2010-1	ND (0.15)	ND (0.15)	ND (0.2)	ND (0.15)	ND (0.25)
2011-1	ND (0.2)	ND (0.4)	ND (0.4)	ND (0.4)	ND (0.4)
2012-1	ND (0.45)	ND (0.45)	3.2	ND (0.45)	0.48 J

41755WL-03

Year	PCE	TCE	cis-DCE	1,1-DCE	VC
1999-2	-	47	2,100	-	-
2000-2	ND (0.12)	9.19	1,054	2.58	0.95 J
2001-2	R	120	2,200	6.5 J	R
2006-1	ND (0.31)	1.65	423	2.12 J	1.95
2007-1	ND (0.31)	5.46	753	3.01	1.61
2009-1	ND (1)	1.2	1,100	3.7	ND (50)
2010-1	0.26	1.6	580	1.9	0.91
2011-1	ND (2)	1.4	410	1.7	ND (4)
2012-1	0.29 J	22 J	490	1.3 J	1.2 J

DP98INJ-02

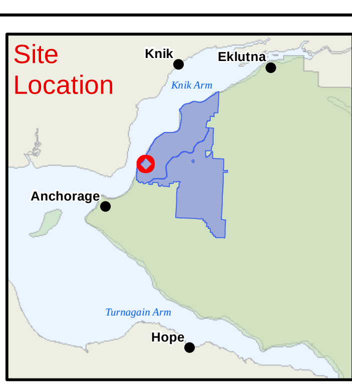
Year	PCE	TCE	cis-DCE	1,1-DCE	VC
2005-1	ND (9.2)	4,920	6,340	22	ND (6.2)
2005-2	ND (9.2)	1,980	4,690	ND (4.4)	ND (6.2)
2006-1	ND (6)	ND (5.4)	11,100	44	74
2006-2	ND (15)	ND (13.5)	7,820	ND (23)	ND (19)
2008-1	ND (1)	15	11,000	44	200
2009-1	ND (1)	0.66 J	11,000	38	79
2011-1	ND (40)	ND (80)	8,600	29	260
2012-1	ND (0.45)	1.3 J	9,300 J	ND (0.45)	400 J

41755WL-02

Year	PCE	TCE	cis-DCE	1,1-DCE	VC
1999-2	2,800	2,300	4,200	9.1	-
2000-2	2,989	2,288	2,490	6.9	0.61 J
2001-2	6,400	4,400	4,000	R	R
2004-1	1,100	1,000	2,600	10	1.2
2005-1	1,300	1,100	2,500	R	R
2006-1	1,240	1,870	6,370	12.7 J	1.36
2007-1	1,020	1,230	2,910	7.59	ND (0.31)
2009-1	1,300	1,300	2,000	5.1	0.62 J
2010-1	650	1,200	2,100	2.8	ND (0.25)
2011-1	1,300 J	1,100 J	2,900 J	ND (20) J	ND (20) J
2012-1	450	570	1,400	2.4	0.31 J

41755WL-01

Year	PCE	TCE	cis-DCE	1,1-DCE	VC
1999-2	ND (0.5)	0.8	-	-	-
2000-2	R	7.29 J	0.94	R	R
2001-2	9.5 J	ND (5.9)	ND (5.8)	ND (6)	ND (10.6)
2004-1	ND (0.2)	0.36	2.5	ND (0.28)	ND (0.27)
2005-1	ND (7.6)	ND (6.2)	ND (2)	ND (7.2)	ND (2.4)
2006-1	ND (0.31)	ND (0.31)	0.87 J	ND (0.31)	ND (0.31)
2007-1	ND (0.31)	ND (0.31)	ND (0.31)	ND (0.31)	ND (0.31)
2012-1	ND (0.45)	0.18 J	0.41 J	ND (0.45)	ND (0.45)



cis-DCE > 1,000 µg/L
cis-DCE > 70 µg/L
DRO > 10,000 µg/L
DRO > 1,500 µg/L
PCE > 1,000 µg/L
PCE > 5 µg/L
TCE > 1,000 µg/L
TCE > 5 µg/L
VC > 10 µg/L
VC > 2 µg/L

Surface Water Sample Location
Program Monitoring Well
Non-Program Monitoring Well
CERCLA Site Boundary
Land Use Control Boundary

N

All Locations Are Approximate

0 30 60 90 120
Feet

WGS 1984 UTM Zone 6N

NOTES:
1. All groundwater results are in micrograms/liter [µg/L].
2. Red results exceed cleanup criteria.
TCE (Trichloroethene) (5 µg/L*)
PCE (Tetrachloroethene) (5 µg/L*)
cis-DCE (Dichloroethene) (70 µg/L*)
1,1 DCE (Dichloroethene) (7 µg/L*)
VC (Vinyl Chloride) (2 µg/L*)
ND = Not Detected (Detection Limit)
NA = Not Analyzed
* Analyte Cleanup Criteria
FLAGS:
J - Analyte was positively identified, but result is estimated.
R - The result was rejected.

DP098 SITE MAP AND HISTORICAL DATA

JOINT BASE ELMENDORF-RICHARDSON, ALASKA

JACOBS	DATE: 11 MAR 2014	PROJECT MANAGER: K. MAHER	FIGURE NO: C-22

P:\JBER\AFCEE-08\TO142_FiveYearReview\MXD\Elmendorf5Yr_2013\DP98_SiteMapAndHistoricalData.mxd beatyc

APPENDIX D

Inspection Checklists

(Available on CD – click the link above to open)

APPENDIX E

Interview Documentation

US Air Force Announces Start of Five-Year Review

The 673d Air Base Wing at Joint Base Elmendorf-Richardson (JBER) announces the beginning of the Five-Year Review of cleanup remedies implemented at Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) sites.

The purpose of the Five-Year Review is to evaluate whether the remedies selected to clean up contaminated sites are operating as designed and continue to remain protective of human health and the environment. The U.S. Environmental Protection Agency and Alaska Department of Environmental Conservation also are participating in this review.

Reviews are conducted at least once every five years until contaminant levels allow unlimited use of the site and unrestricted exposure to the air, soil and water. Detailed information concerning JBER cleanup efforts is available in the information repository at:

Alaska Resources Library & Information Services
University of Alaska, Anchorage Consortium Library
3211 Providence Drive
(907) 786-1871

The findings of the Five-Year Review will be placed in the information repository in July 2013.

Interested persons can participate in the Five-Year Review process through September 2012 by responding to a questionnaire available from:

Kevin Maher, Jacobs Engineering
4300 B Street, Suite 600
Anchorage, AK 99508
kevin.maher@jacobs.com (907) 563-3322

Information on the cleanup process is distributed to interested persons through periodic JBER Environmental Restoration Program Fact Sheets. If you want to be added to the mailing list, contact Cynthia Tomlinson at (907) 552-3230 or cynthia.tomlinson@us.af.mil.

August 2012

Print Form

Interview Record

Name:	Bruce Henry	Date:	15 August 2012
Organization:	Parsons	Phone Number:	303-831-8100
Title:	Project Manager	Email:	bruce.henry@parsons.com

Interview Type: ☒ Mail/Email ☐ Phone/In Person

The following questions are from the U. S. Environmental Protection Agency (EPA) Comprehensive Five-Year Review Guidance. Please answer the questions when they are applicable to your experience with the cleanup activities at Joint Base Elmendorf-Richardson (JBER), Alaska. Questions can be left unanswered if they do not apply to you.

Interview Questions

1. What is your overall impression of the restoration effort at JBER, Alaska? (general sentiment)

The program is well managed and the JBER restoration program managers are excellent people to work with.

2. What effects do you think site operations have had on the surrounding community? Are you aware of any community concerns or complaints regarding any site or its operations? If so, please provide details.

Site operations have had little, if any, effect on the surrounding community.

3. Are you aware of any events, incidents, or activities at any site such as vandalism, trespassing, or emergency responses from local authorities? If so, please provide details of the events and results of the responses.

None.

4. Do you feel well informed about site activities and cleanup progress?

This information is generally available through RAB meetings.

5. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding a site? If so, please give purpose and results.

Annual inspections were performed for the wetlands remediation system. No adverse conditins were observed.

6. Is there a continuous on-site operations and maintenance (O&M) presence at the site? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities.

None.

7. Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines since start-up or in the last five years? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe changes and impacts.

No significant changes, although some optimization of monitoring schedules has been performed.

8. Have any problems been encountered at the site which required, or will require, changes to the cleanup activity?

None.

9. Are you aware of any changes in land use, access, or other site conditions that have occurred since the last Five-Year Review (2008) that you feel may impact the protectiveness or effectiveness of the remedy?

None.

10. Have there been unexpected O&M difficulties or costs at the site since start-up or in the last five years? If so, please give details or reference reports.

None.

11. Have there been opportunities to optimize O&M or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency, or reference remedial process optimization or another report.

I believe there have been efforts to optimize O&M and sampling schedules, but I am not familiar with them.

12. Do you have any comments, suggestions, or recommendations regarding cleanup activities at Joint Base Elmendorf-Richardson?

No, not since the program has gone to a performance based contract with which I am not familiar.

Print Form

Interview Record

Name: Louis Howard	Date: August 13, 2012
Organization: DEC	Phone Number: (907) 269-7552
Title:	Email: louis.howard@alaska.gov
Interview Type: ☒ Mail/Email	☐ Phone/In Person

The following questions are from the U. S. Environmental Protection Agency (EPA) Comprehensive Five-Year Review Guidance. Please answer the questions when they are applicable to your experience with the cleanup activities at Joint Base Elmendorf-Richardson (JBER), Alaska. Questions can be left unanswered if they do not apply to you.

Interview Questions

1. What is your overall impression of the restoration effort at JBER, Alaska? (general sentiment)

The IRP program at JBER is a well run organization. While current federal hiring freezes prevent backfilling of environmental management and key staff positions with new personnel, they are doing the best they can with what they have and should be commended for it.

2. What effects do you think site operations have had on the surrounding community? Are you aware of any community concerns or complaints regarding any site or its operations? If so, please provide details.

The site operations have had an overall positive effect on the surrounding community. I am not aware of any community concerns or complaints regarding any site or its operations.

3. Are you aware of any events, incidents, or activities at any site such as vandalism, trespassing, or emergency responses from local authorities? If so, please provide details of the events and results of the responses.

No.

4. Do you feel well informed about site activities and cleanup progress?

JBER's IRP program is the most responsive and open federal facility program I have dealt with.

5. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding a site? If so, please give purpose and results.

Yes. The regular site visits are those that might occur during a federal facility agreement meeting, inspections of investigations or cleanups during the field seasons or CEB tour.

6. Is there a continuous on-site operations and maintenance (O&M) presence at the site? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities.

The Air Force has a continuous presence for O&M activities for long-term monitoring and Land Use Controls management.

7. Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines since start-up or in the last five years? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe changes and impacts.

O&M changes occur regularly and can be due to cleanup complete at a site, removing equipment used for cleanup, additional removal actions due to new sources being found or new information. The Air Force has gone to a Performance Based Contract approach for most of its sites on JBER (aka Elmendorf/Richardson). The 8 year contract for this approach should not affect the protectiveness or effectiveness of any remedies. Optimization and innovation are possible under the contract which could change the remedies.

8. Have any problems been encountered at the site which required, or will require, changes to the cleanup activity?

See the semi-annual reports and last Five-Year Review for Elmendorf Air Force Base and Fort Richardson.

9. Are you aware of any changes in land use, access, or other site conditions that have occurred since the last Five-Year Review (2008) that you feel may impact the protectiveness or effectiveness of the remedy?

No.

10. Have there been unexpected O&M difficulties or costs at the site since start-up or in the last five years? If so, please give details or reference reports.

No.

11. Have there been opportunities to optimize O&M or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency, or reference remedial process optimization or another report.

See the semi-annual reports and last Five-Year Review for Elmendorf Air Force Base and Fort Richardson.

12. Do you have any comments, suggestions, or recommendations regarding cleanup activities at Joint Base Elmendorf-Richardson?

No.

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By____________

Interview Record

Name: Arthur D. Isham	Date: 8/14/12
Organization: Alaska Aerospace Corporation	Phone Number: 561-3338
Title: Director of Contracts, Logistics and Administration	Email: art.isham@akaerospace.com
Interview Type: Mail/Email	Phone/In Person

The following questions are from the U. S. Environmental Protection Agency (EPA) Comprehensive Five-Year Review Guidance. Please answer the questions when they are applicable to your experience with the cleanup activities at Joint Base Elmendorf-Richardson (JBER), Alaska. Questions can be left unanswered if they do not apply to you.

Interview Questions

1. What is your overall impression of the restoration effort at JBER, Alaska? (general sentiment)

   It is working. The USAF is doing all that it can within its budget restraints.

2. What effects do you think site operations have had on the surrounding community? Are you aware of any community concerns or complaints regarding any site or its operations? If so, please provide details.

   The community is generally aware that the USAF is cleaning up past environmental problems, and is very prompt in dealing with newly created or discovered environmental problems.

3. Are you aware of any events, incidents, or activities at any site such as vandalism, trespassing, or emergency responses from local authorities? If so, please provide details of the events and results of the responses.

NO

4. Do you feel well informed about site activities and cleanup progress?

yes

5. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding a site? If so, please give purpose and results.

NO

6. Is there a continuous on-site operations and maintenance (O&M) presence at the site? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities.

~~U~~ Unknown

7. Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines since start-up or in the last five years? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe changes and impacts.

Unknown

8. Have any problems been encountered at the site which required, or will require, changes to the cleanup activity?

Unknown

9. Are you aware of any changes in land use, access, or other site conditions that have occurred since the last Five-Year Review (2008) that you feel may impact the protectiveness or effectiveness of the remedy?

NO

10. Have there been unexpected O&M difficulties or costs at the site since start-up or in the last five years? If so, please give details or reference reports.

Unknown

11. Have there been opportunities to optimize O&M or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency, or reference remedial process optimization or another report.

Unknown

12. Do you have any comments, suggestions, or recommendations regarding cleanup activities at Joint Base Elmendorf-Richardson?

I am a member of the Community Environmental Board for JBER. We are well informed on all actions occuring at JBER. Questions are answered promptly and the staff seems qualified and interested in cleaning up past problems and preventing future pollution.

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By

Interview Record

Name: SKIP KOCH	Date: 6 SEP 12
Organization: WESTON SOLUTIONS	Phone Number: 343-2710
Title: PROJECT MANAGER	Email: SKIP.KOCH@WESTONSOLUTIONS.COM
Interview Type: Mail/Email	Phone/In Person

The following questions are from the U. S. Environmental Protection Agency (EPA) Comprehensive Five-Year Review Guidance. Please answer the questions when they are applicable to your experience with the cleanup activities at Joint Base Elmendorf-Richardson (JBER), Alaska. Questions can be left unanswered if they do not apply to you.

Interview Questions

1. What is your overall impression of the restoration effort at JBER, Alaska? (general sentiment)

   The base is doing a good job investigating and cleaning up contaminated sites.

2. What effects do you think site operations have had on the surrounding community? Are you aware of any community concerns or complaints regarding any site or its operations? If so, please provide details.

   I am not aware of any environmental impacts on the surrounding community.

3. Are you aware of any events, incidents, or activities at any site such as vandalism, trespassing, or emergency responses from local authorities? If so, please provide details of the events and results of the responses.

No

4. Do you feel well informed about site activities and cleanup progress?

Yes

5. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding a site? If so, please give purpose and results.

Weston prepares annual groundwater reports on JBER. We have also prepared and presented briefings on the closure of the OU 1 Landfills to site visitors.

6. Is there a continuous on-site operations and maintenance (O&M) presence at the site? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities.

We perform the O&M of the OU 5 constructed wetland. We visit the site at least twice a month. We also perform monthly inspections on the OU 1 Landfills during the growing season.

7. Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines since start-up or in the last five years? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe changes and impacts.

No

8. Have any problems been encountered at the site which required, or will require, changes to the cleanup activity?

No

9. Are you aware of any changes in land use, access, or other site conditions that have occurred since the last Five-Year Review (2008) that you feel may impact the protectiveness or effectiveness of the remedy?

No

10. Have there been unexpected O&M difficulties or costs at the site since start-up or in the last five years? If so, please give details or reference reports.

No

11. Have there been opportunities to optimize O&M or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency, or reference remedial process optimization or another report.

No

12. Do you have any comments, suggestions, or recommendations regarding cleanup activities at Joint Base Elmendorf-Richardson?

I think they are doing a good job managing and cleaning up sites.

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By

Interview Record

Name: (b) (6) [redacted]	Date: 9-12-2012
Organization: JBER	(b) (6) [redacted]
Title: Public Interest	
Interview Type: Mail/Email	Phone/In Person

The following questions are from the U. S. Environmental Protection Agency (EPA) Comprehensive Five-Year Review Guidance. Please answer the questions when they are applicable to your experience with the cleanup activities at Joint Base Elmendorf-Richardson (JBER), Alaska. Questions can be left unanswered if they do not apply to you.

Interview Questions

1. What is your overall impression of the restoration effort at JBER, Alaska? (general sentiment)

   Over-all impression is good, although too much is often left for natural attenuation.

2. What effects do you think site operations have had on the surrounding community? Are you aware of any community concerns or complaints regarding any site or its operations? If so, please provide details.

   Any effort to make environmental assessment and cleanup is positive. I'm not aware of specific complaints.

3. Are you aware of any events, incidents, or activities at any site such as vandalism, trespassing, or emergency responses from local authorities? If so, please provide details of the events and results of the responses.

No

4. Do you feel well informed about site activities and cleanup progress?

Yes, I attend meetings with the cleanup folks and follow their activities and progress.

5. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding a site? If so, please give purpose and results.

We do have summer site visits.

6. Is there a continuous on-site operations and maintenance (O&M) presence at the site? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities.

I believe there is - by the Environmental Restoration folks.

7. Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines since start-up or in the last five years? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe changes and impacts.

Not that I'm aware of.

8. Have any problems been encountered at the site which required, or will require, changes to the cleanup activity?

This depends upon which site. I believe new sites have been discovered, while some has received complete remediation and others are ongoing remediation.

9. Are you aware of any changes in land use, access, or other site conditions that have occurred since the last Five-Year Review (2008) that you feel may impact the protectiveness or effectiveness of the remedy?

No

10. Have there been unexpected O&M difficulties or costs at the site since start-up or in the last five years? If so, please give details or reference reports.

Not aware

11. Have there been opportunities to optimize O&M or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency, or reference remedial process optimization or another report.

    Not aware.

12. Do you have any comments, suggestions, or recommendations regarding cleanup activities at Joint Base Elmendorf-Richardson?

Print Form

Interview Record

Name: Christian Ryll	Date: 8-15-12
Organization: Alaska Railroad	Phone Number: 907-265-2527
Title: Facilities Engineer	Email: ryllc@akrr.com
Interview Type: ☒ Mail/Email	☐ Phone/In Person

The following questions are from the U. S. Environmental Protection Agency (EPA) Comprehensive Five-Year Review Guidance. Please answer the questions when they are applicable to your experience with the cleanup activities at Joint Base Elmendorf-Richardson (JBER), Alaska. Questions can be left unanswered if they do not apply to you.

Interview Questions

1. What is your overall impression of the restoration effort at JBER, Alaska? (general sentiment)

That the remediation activities continue and will for the foreseeable future

2. What effects do you think site operations have had on the surrounding community? Are you aware of any community concerns or complaints regarding any site or its operations? If so, please provide details.

Alaska Railroad has been hindered in expanding its yard in part due to the continued operations at OU5.

3. Are you aware of any events, incidents, or activities at any site such as vandalism, trespassing, or emergency responses from local authorities? If so, please provide details of the events and results of the responses.

Coordination with local wildlife officers has been required to remove beavers.

4. Do you feel well informed about site activities and cleanup progress?

No

5. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding a site? If so, please give purpose and results.

I have been advised of construction activities on OU5 and of beaver activity.

6. Is there a continuous on-site operations and maintenance (O&M) presence at the site? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities.

I don't believe there is continuous on-site O&M. I am not usually advised of site inspections because JBER has direct access to the site. I understand that JBER's contractors advise Alaska Railroad's Terminal Supervisors of on-site activities.

7. Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines since start-up or in the last five years? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe changes and impacts.

I believe that the remediation activities at OU5 have changed from active to passive. That the groundwater is no longer being pumped and that overland flow has been found to be adequate to remediate the water.

8. Have any problems been encountered at the site which required, or will require, changes to the cleanup activity?

Not that I know of.

9. Are you aware of any changes in land use, access, or other site conditions that have occurred since the last Five-Year Review (2008) that you feel may impact the protectiveness or effectiveness of the remedy?

No

10. Have there been unexpected O&M difficulties or costs at the site since start-up or in the last five years? If so, please give details or reference reports.

Other than beaver activity and Alaska Railroad access road maintenance activities, no.

11. Have there been opportunities to optimize O&M or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency, or reference remedial process optimization or another report.

Not that know of.

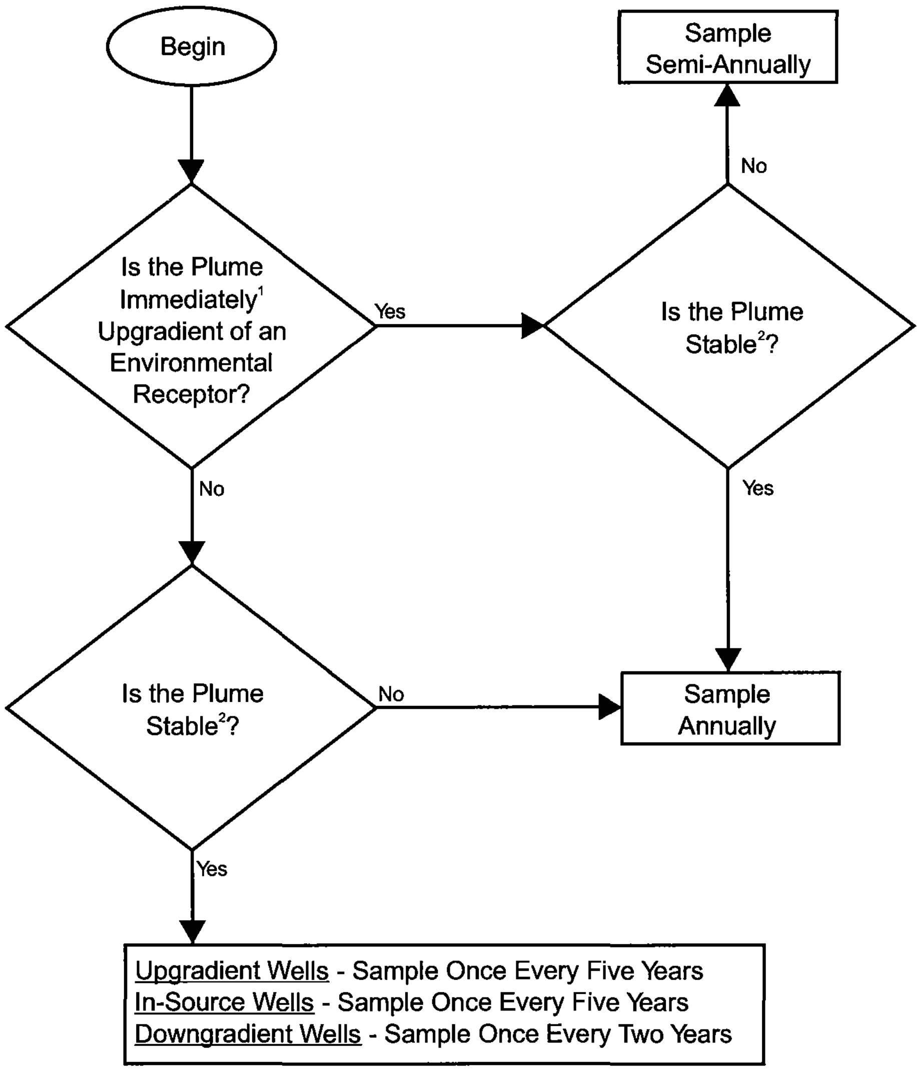
12. Do you have any comments, suggestions, or recommendations regarding cleanup activities at Joint Base Elmendorf-Richardson?

No

APPENDIX F

Decision Guides

FIGURE F-1
Basewide Monitoring Program
Well Sampling Frequency Decision Guide as Adapted for OU 4, 5, and 6



Definitions:

[1] Immediately Upgradient: **Means within a two-year warning line, similar to that generated for OU 5.**

[2] **Stable Plume:** A stable plume has defined boundaries with stable or decreasing contaminant concentrations.

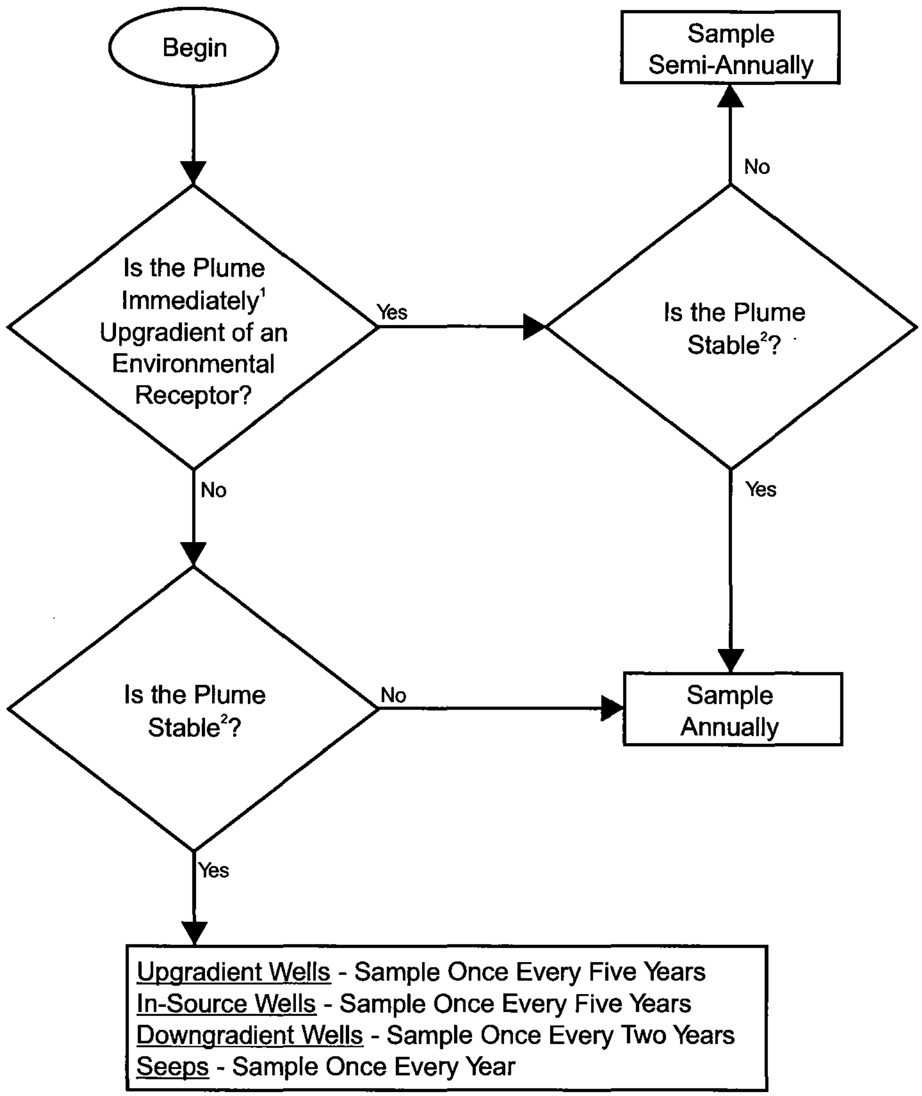
In 2003, the following plumes were not considered stable:

- Slammer/Arctic Warrior Plume
- Fairchild/Arctic Warrior Plume
- Kenney Avenue Plume
- SP1-02 Plume

Notes:

1. Seep are sampled annually, unless they exceed cleanup levels in which case they are sampled quarterly.
2. Wells with historical free product will be monitored annually for free product occurrence. Active product recovery will continue in wells with recoverable free product.
3. Sampling frequencies can be modified as needed to support site closure or modeling results.
4. Surface water sampling at OU 5 (Ship Creek) will be performed annually.

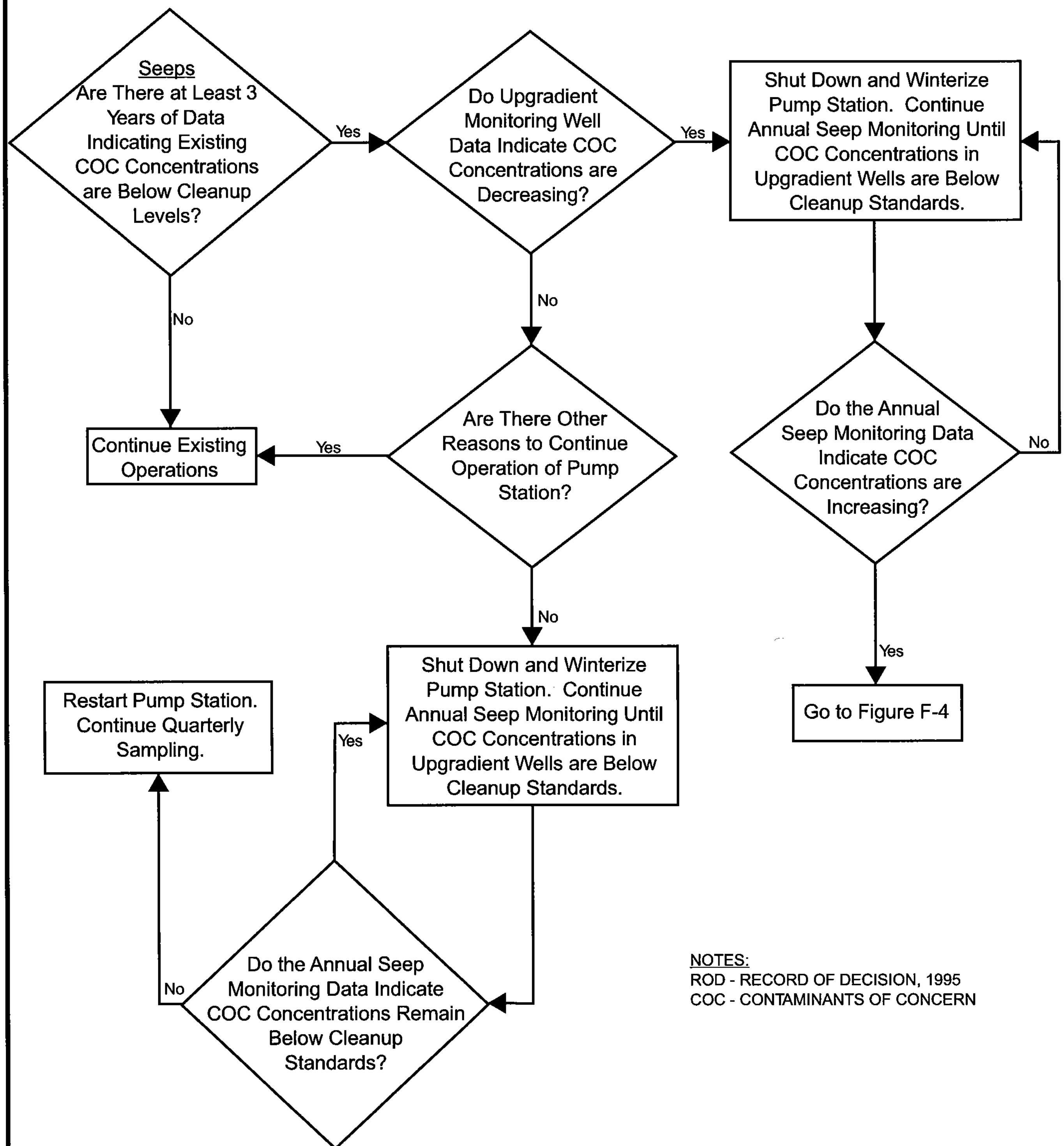
FIGURE F-2
Basewide Monitoring Program
Well Sampling Frequency Decision Guide as Adapted for DP98



[1] **Immediately Upgradient:** Within a two-year warning line. The warning line is defined as the distance groundwater travels in two years, ignoring retardation processes, and measure from a receptor (i.e. the kettle pond).

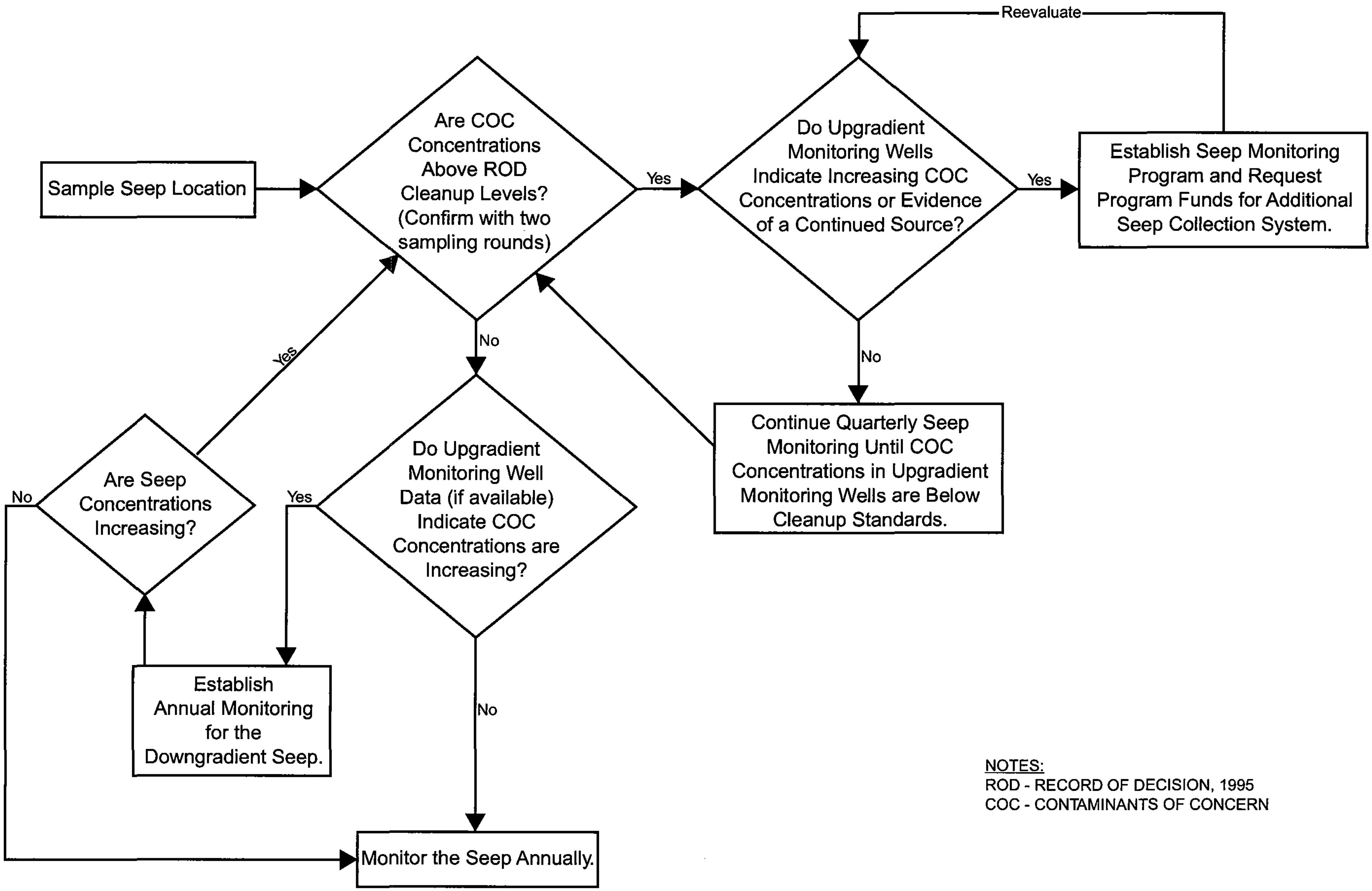
[2] **Stable Plume:** A stable plume has defined boundaries with stable or decreasing contaminant concentrations.

FIGURE F-3
Decision Guide for Shutting Down Pump Stations at OU5



NOTES:
ROD - RECORD OF DECISION, 1995
COC - CONTAMINANTS OF CONCERN

FIGURE F-4
Decision Guide for Restarting an Existing Seep Collection Area or Adding a New Seep Collection Area for Treatment at OU5



NOTES:
ROD - RECORD OF DECISION, 1995
COC - CONTAMINANTS OF CONCERN

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APPENDIX G

Contaminant Trend Analyses

APPENDIX G: TREND ANALYSIS

ProUCL version 4.1.00 statistical software package was used to evaluate trends in groundwater concentration data. ProUCL version 4.1.00 was the latest update available at the time of the analysis in April 2013. This version includes statistical methods and graphical tools to address many environmental sampling and statistical issues. Mann-Kendall non-parametric tests were conducted on select monitoring well data to assess contaminant concentration trends over time. Monitoring wells receiving trend analysis were selected specifically for the five-year review. In-plume and downgradient wells were given priority in the selection process. For DP098, wells were chosen with TCE as the driver.

MANN-KENDALL TEST

The Mann-Kendall test can determine whether contaminant concentrations have no identifiable trend, or whether a trend is significantly increasing or decreasing with time. This test is well suited for environmental data because it requires only small sample sizes (at least four data points) and does not assume any underlying distribution for the data. Trends were identified as "increasing" or "decreasing" if the significance of Mann-Kendall test was at least 95 percent; otherwise, the results were classified as exhibiting "no identifiable trend."

The Mann-Kendall procedure is a non-parametric test for a significant slope in a linear regression of the concentration values plotted against time of sampling. However, the Mann-Kendall statistic S does not indicate the magnitude of the slope or estimate the trend line itself, even when a trend is present. For this reason, the Theil-Sen trend line was also established.

THEIL SEN PROCEDURE

If a simple slope estimate is computed for every pair of distinct measurements in the sample (known as the set of pairwise slopes), the average of this series of slope values should approximate the true slope.

For the Theil-Sen procedure, the actual concentration values are important in computing the slope estimate. The Theil-Sen method is non-parametric that determines the median slope value of the pairwise slopes. By taking the median pairwise slope instead of the mean, extreme pairwise slopes that may be due to one or more outliers or other errors are ignored and have little impact on the final slope estimator.

The Theil-Sen trend line is also non-parametric because the median pairwise slope is combined with the median concentration value and the median sample date to construct the final trend line. As a consequence of this construction, the Theil-Sen line estimates the change in median concentration over time and not the mean as in linear regression.

ATTACHMENT G-1

Input Data

OU1 (LF059)

LF59MW-03		
Date	Date	TCE Concentration (µg/L)
9/25/1992	33872	6.2
5/25/1995	34844	8
10/30/1995	35002	7.4
5/9/1996	35194	8.8
5/14/1997	35564	9.9
8/22/1997	35664	7.6
6/9/1998	35955	9.9
8/26/1998	36033	10.1
6/16/1999	36327	11
8/20/1999	36392	8.4
6/14/2000	36691	9
8/22/2000	36760	9.9
6/20/2001	37062	9
6/12/2002	37419	9.9
6/25/2003	37797	10
7/6/2004	38174	8.9
7/14/2005	38547	8.2
7/5/2006	38903	8
6/13/2007	39246	6.9
6/13/2008	39612	0.22
2/23/2009	39867	6.8
6/1/2010	40330	8.1
8/27/2011	40782	9.3
8/8/2012	41129	8.8

LF05GW-2B		
Date	Date	TCE Concentration (µg/L)
10/6/1986	31691	2.3
8/9/1988	32364	3
9/9/1991	33490	8.2
6/26/1992	33781	3.7
10/2/1992	33879	6
5/23/1995	34842	5.8
10/25/1995	34997	7.9
5/10/1996	35195	4.6
9/11/1996	35319	3.8
5/8/1997	35558	2.6
8/18/1997	35660	1.8
1/1/2006	38718	15
4/1/2006	38808	16
8/1/2006	38930	13
10/12/2006	39002	12
1/19/2007	39101	13
4/1/2007	39173	11
8/1/2007	39295	8.8
12/1/2007	39417	7.7
1/21/2008	39468	6.8
4/1/2008	39539	6.1
8/1/2008	39661	5.4
12/1/2008	39783	5.7
1/1/2009	39814	4.7
4/1/2009	39904	6.7
8/1/2009	40026	5.5
12/1/2009	40148	6.4
1/1/2010	40179	5
4/1/2010	40269	5.2
8/1/2010	40391	4.7
12/1/2010	40513	5.9
1/1/2011	40544	4.4
4/1/2011	40634	4.4
8/1/2011	40756	4.7
12/1/2011	40878	5.9

OU1LF-19		
Date	Date	TCE Concentration (µg/L)
10/14/06	39004	26
1/19/07	39101	27
4/1/07	39173	26
8/1/07	39295	23
12/1/07	39417	22
1/22/08	39469	20
4/1/08	39539	15
8/1/08	39661	15
12/1/08	39783	14
1/1/09	39814	13
4/1/09	39904	17
8/1/09	40026	15
12/1/09	40148	12
1/1/10	40179	12
4/1/10	40269	12
8/1/10	40391	8.7
12/1/10	40513	11
1/1/11	40544	8.4
4/1/11	40634	8.9
8/1/11	40756	8.6
12/1/11	40878	1

OU2 (ST041)

ST41-28				
Date	Date	Benzene Concentration (µg/L)	Ethylbenzene Concentration (µg/L)	Toluene Concentration (µg/L)
1/1/1996	35065	651	1470	2270
2/1/1996	35096	737	1360	2730
1/1/1997	35431	460	1100	1700
2/1/1997	35462	540	1200	1900
1/1/1998	35796	367	809	311
2/1/1998	35827	356	754	870
1/1/1999	36161	310	1000	170
2/1/1999	36192	270	700	180
1/1/2000	36526	270	680	160
2/1/2000	36557	300	950	230
1/1/2001	36892	190	510	63
2/1/2001	36923	260	770	81
1/1/2002	37257	270	830	76
1/1/2009	39814	170	600	10
1/1/2010	40179	130	530	8
1/1/2011	40544	130	490	4
1/1/2012	40909	80	440	0.94

ST41-16				
Date	Date	Benzene Concentration (µg/L)	Ethylbenzene Concentration (µg/L)	Toluene Concentration (µg/L)
1/1/1992	33604	30000	6100	18000
2/1/1992	33635	18000	4700	20000
1/1/1996	35065	15100	1960	14700
1/2/1996	35066	13500	1660	13600
1/1/1997	35431	14000	2700	15000
1/2/1997	35432	16000	2600	16000
1/1/1998	35796	13600	2480	16300
1/2/1998	35797	17600	1840	18900
1/1/1999	36161	17000	23000	1100
1/2/1999	36162	13000	1600	13000
1/1/2000	36526	13000	2700	17000
2/1/2000	36557	16000	2200	19000
1/1/2001	36892	14000	1800	17000
1/2/2001	36893	11000	1500	12000
1/1/2002	37257	13000	1700	16000
1/1/2009	39814	12000	2200	16000
1/1/2010	40179	8000	1500	11000
1/1/2011	40544	7700	1600	9400
1/1/2012	40909	5300	1400	7700

OU4 (FT023)

FP-56		
Date	Date	TCE Concentration (µg/L)
7/4/1988	32328	250
5/30/1993	34119	268
7/31/1993	34181	180
8/25/1993	34206	398
6/7/1995	34857	137
9/12/1995	34954	174
6/5/1996	35221	102
10/3/1996	35341	75
5/22/1997	35572	51
8/29/1997	35671	47
5/26/1998	35941	17
8/11/1998	36018	16
6/6/1999	36317	8.7
8/10/1999	36382	8.4
6/3/2000	36680	12
8/8/2000	36746	13
6/11/2001	37053	8.7
8/21/2001	37124	7.2
6/25/2002	37432	3.5
8/21/2002	37489	4.2
6/19/2003	37791	6.3
7/8/2004	38176	5.5
7/11/2005	38544	0.95
7/10/2006	38908	3.1
6/19/2007	39252	3.3
9/19/2007	39344	3.9
6/13/2008	39612	0.81
6/16/2009	39980	0.76
6/16/2010	40345	0.2
9/15/2011	40801	0.55

GW-5A		
Date	Date	TCE Concentration (µg/L)
5/25/1993	34114	46
7/31/1993	34181	16
8/31/1993	34212	49
6/13/2008	39612	31
6/16/2009	39980	29

OU4MW-11				
Date	Date	PCE Concentration (µg/L)	TCE Concentration (µg/L)	cis-DCE Concentration (µg/L)
7/28/1993	34178	33	78	741
8/30/1993	34211	25	41	476
6/7/1995	34857	56	52	904
9/12/1995	34954	65	44	241
6/5/1996	35221	12	21	462
10/2/1996	35340	28	21	195
5/22/1997	35572	28	50	470
8/29/1997	35671	45	27	170
5/28/1998	35943	78	56	247
8/13/1998	36020	94	50	125
6/6/1999	36317	68	43	360
8/12/1999	36384	48	29	400
6/3/2000	36680	96	53	340
8/8/2000	36746	75	52	460
6/11/2001	37053	78	41	410
8/21/2001	37124	37	30	360
6/25/2002	37432	53	33	400
8/21/2002	37489	24	24	360
6/16/2003	37788	12	17	410
7/13/2004	38181	11	12	350
7/11/2005	38544	15	16	210
7/10/2006	38908	7.3	5.8	230
6/19/2007	39252	30	26	140
6/13/2008	39612	12	13	160
6/16/2009	39980	13	14	140
8/1/2012	41122	6.7	7.7	81

OU4 (SD025)

OU4MW-08R				
Date	Date	Benzene Concentration (µg/L)	Toluene Concentration (µg/L)	Ethylbenzene Concentration (µg/L)
10/12/2003	37906	1500	6800	1100
7/12/2004	38180	4400	16000	1400
7/11/2005	38544	4300	15000	1500
7/10/2006	38908	980	5200	880
6/19/2007	39252	600	4000	940
6/10/2008	39609	350	11000	1200
6/15/2009	39979	360	10000	1300
6/8/2010	40337	740	11000	1700
9/16/2011	40802	800	12000	1500
8/13/2012	41134	610	31000	1600

OU4 (SD029)

IS6-01			
Date	Date	TCE Concentration (µg/L)	PCE Concentration (µg/L)
8/18/1988	32373	8.1	12
6/9/1993	34129	21	20
7/31/1993	34181	17	17
8/26/1993	34207	23	18
7/29/1996	35275	17	14
10/21/1996	35359	11	12
7/2/2002	37439	10	7.5
8/22/2002	37490	12	7.2
10/14/2005	38639	5.4	3.8
6/11/2008	39610	6.3	5.2
6/17/2009	39981	5.7	3.8
6/16/2010	40345	5.1	4.1
9/19/2011	40805	5.8	4.4

OU5 (Fairchild Plume)

49WL-01		
Date	Date	TCE Concentration (µg/L)
9/26/1995	34968	45
5/7/1996	35192	43
9/23/1996	35331	59
6/13/1997	35594	59
9/22/1997	35695	67
5/22/1998	35937	48
8/13/1998	36020	62
6/4/1999	36315	52
8/12/1999	36384	41
5/31/2000	36677	42
8/4/2000	36742	40
6/12/2001	37054	36
8/22/2001	37125	39
6/4/2002	37411	35
8/16/2002	37484	34
10/12/2003	37906	28
7/6/2004	38174	23
6/28/2005	38531	18
7/17/2006	38915	23
6/5/2007	39238	21

OU5MW-34		
Date	Date	TCE Concentration (µg/L)
9/10/2002	37509	42
10/13/2003	37907	44
7/1/2004	38169	41
6/28/2005	38531	45
7/18/2006	38916	52
6/5/2007	39238	44
6/17/2008	39616	35
6/18/2009	39982	34
6/3/2010	40332	40
8/26/2011	40781	34
8/20/2012	41141	40

OU5MW-38		
Date	Date	TCE Concentration (µg/L)
7/1/2004	38169	8.5
6/29/2005	38532	11
7/18/2006	38916	13
6/6/2007	39239	11
6/16/2008	39615	11
6/18/2009	39982	11
6/3/2010	40332	12
8/26/2011	40781	13
8/20/2012	41141	13

OU5 (OU5MW-02 Plume)

OU5MW-44		
Date	**Date**	**TCE Concentration (µg/L)**
8/5/2004	38204	26
7/6/2005	38539	25
7/21/2006	38919	35
6/7/2007	39240	30
6/18/2008	39617	27
6/23/2009	39987	22
6/4/2010	40333	24
9/28/2011	40814	23
8/21/2012	41142	25

OU5 (Kenney Avenue Plume)

403WL-01		
Date	Date	TCE Concentration (µg/L)
6/1/2001	37043	66
6/3/2002	37410	53
10/12/2003	37906	44
6/29/2004	38167	41
7/5/2005	38538	35
7/20/2006	38918	56
8/22/2006	38951	36
9/19/2006	38979	34
5/23/2007	39225	42
5/30/2007	39232	25
6/6/2007	39239	47
9/13/2007	39338	35
6/20/2008	39619	35
6/19/2009	39983	25
6/2/2010	40331	23
8/26/2011	40781	23
8/20/2012	41141	29

OU5SP-10		
Date	Date	TCE Concentration (µg/L)
3/21/2008	39528	6.8
6/24/2008	39623	7.6
9/18/2008	39709	7.2
12/10/2008	39792	6.4
3/25/2009	39897	7.2
6/2/2009	39966	7.1
9/25/2009	40081	8.9
3/15/2010	40252	6.2
6/5/2010	40334	7.7
9/7/2010	40428	6.6
12/2/2010	40514	8.8
3/15/2011	40617	9.1
6/24/2011	40718	6.6
1/11/2012	40919	7.4
8/16/2012	41137	8.5

OU5SP-11		
Date	Date	TCE Concentration (µg/L)
3/21/2008	39528	7.6
6/24/2008	39623	7.8
9/18/2008	39709	7.6
12/10/2008	39792	7.3
3/25/2009	39897	9.4
6/2/2009	39966	9.4
9/25/2009	40081	7.8
3/15/2010	40252	6.4
6/5/2010	40334	8.2
9/7/2010	40428	6.9
12/2/2010	40514	9
3/15/2011	40617	9.8
6/24/2011	40718	8.5
1/11/2012	40919	9.3
8/16/2012	41137	9.2

OU5 (Slammer Avenue Plume)

OU5MW-06		
Date	Date	TCE Concentration (µg/L)
6/22/1995	34872	45
9/19/1995	34961	45
6/3/1996	35219	44
9/26/1996	35334	46
5/28/1997	35578	46
9/16/1997	35689	39
5/21/1998	35936	36
8/10/1998	36017	47
5/18/1999	36298	34
7/27/1999	36368	33
5/15/2000	36661	28
7/24/2000	36731	26
5/24/2001	37035	25
8/6/2001	37109	29
6/10/2002	37417	30
8/19/2002	37487	37
6/27/2003	37799	30
7/7/2004	38175	22
7/6/2005	38539	18
6/27/2006	38895	23
6/11/2007	39244	19
6/17/2008	39616	19
6/22/2009	39986	16
6/2/2010	40331	17
8/27/2011	40782	14
8/21/2012	41142	15

OU5MW-07		
Date	Date	TCE Concentration (µg/L)
6/22/1995	34872	19
9/19/1995	34961	18
6/3/1996	35219	19
9/26/1996	35334	20
5/28/1997	35578	17
9/9/1997	35682	19
5/20/1998	35935	23
8/10/1998	36017	31
5/14/1999	36294	20
7/28/1999	36369	21
5/15/2000	36661	22
7/24/2000	36731	18
5/24/2001	37035	19
8/6/2001	37109	23
6/6/2002	37413	20
8/19/2002	37487	24
6/30/2003	37802	20
7/7/2004	38175	14
7/7/2005	38540	16
7/20/2006	38918	20
6/12/2007	39245	16
6/19/2008	39618	17
6/22/2009	39986	15
6/2/2010	40331	17
8/27/2011	40782	18
8/20/2012	41141	20

OU5 (SP1-02 Plume)

SP1-02		
Date	Date	TCE Concentration (µg/L)
8/10/1992	33826	33
6/21/1995	34871	33
9/19/1995	34961	49
5/30/1996	35215	50
10/1/1996	35339	34
5/30/1997	35580	30
9/8/1997	35681	21
5/15/1998	35930	17
8/7/1998	36014	22
5/18/1999	36298	20
7/27/1999	36368	18
5/17/2000	36663	19
7/21/2000	36728	30
6/7/2001	37049	21
8/1/2001	37104	16
6/11/2002	37418	16
8/20/2002	37488	12
6/30/2003	37802	64
10/12/2003	37906	22
7/1/2004	38169	16
12/15/2004	38336	22
6/29/2005	38532	33
7/21/2006	38919	25
6/13/2007	39246	19
6/20/2008	39619	16
6/23/2009	39987	9.1
6/7/2010	40336	7
8/26/2011	40781	6.2
8/21/2012	41142	5.4

OU6 (SD015)

OU6MW-17			
Date	Date	Benzene Concentration (µg/L)	TCE Concentration (µg/L)
8/8/1994	34554	183	23.5
9/1/1994	34578	204	23.9
6/10/1996	35226	179	21.1
5/13/1998	35928	84.3	21.3
6/4/1998	35950	110	23.2
6/3/1999	36314	9.3	4.5
8/6/1999	36378	78	14
5/22/2000	36668	160	19
8/7/2000	36745	160	18
6/5/2001	37047	70	11
8/16/2001	37119	39	11
6/19/2002	37426	13	11
8/14/2002	37482	23	9.7
6/24/2003	37796	100	13
7/13/2005	38546	180	12
7/13/2006	38911	86	12
10/5/2006	38995	81	7.2
6/20/2007	39253	150	11
6/11/2008	39610	100	11
6/16/2009	39980	89	9.1
6/7/2010	40336	89	8.7
9/16/2011	40802	100	8.1
8/10/2012	41131	110	11

OU6MW-18			
Date	Date	Benzene Concentration (µg/L)	TCE Concentration (µg/L)
8/7/1994	34553	1,430	143
8/31/1994	34577	1,180	140
6/11/1996	35227	814	151
9/11/1998	36049	0.12	0.9
6/3/1999	36314	43	33
8/9/1999	36381	39	38
5/22/2000	36668	110	54
8/7/2000	36745	9	6.4
6/5/2001	37047	41	27
8/15/2001	37118	41	20
6/23/2003	37795	10	20
7/14/2004	38182	0.9	6.6
7/13/2005	38546	5.9	18
7/17/2006	38915	4.2	24
6/20/2007	39253	15	49
6/11/2008	39610	18	40
6/17/2009	39981	2.6	18
6/8/2010	40337	0.37 F	6

Note:

F = The result is between the method detection limit and the reporting limit.

OU6 (WP014)

OU6MW-46			
Date	Date	Benzene Concentration (µg/L)	Ethylbenzene Concentration (µg/L)
1/1/1994	34335	1020	352
6/1/1994	34486	1390	587
1/1/1996	35065	979	546
6/1/1996	35217	695	410
1/1/1997	35431	690	380
6/1/1997	35582	500	130
1/1/1998	35796	819	731
6/1/1998	35947	937	894
1/1/1999	36161	560	430
6/1/1999	36312	470	460
1/1/2000	36526	400	410
6/1/2000	36678	390	520
1/1/2001	36892	580	570
6/1/2001	37043	700	720
1/1/2002	37257	480	650
6/1/2002	37408	600	870
1/1/2003	37622	550	700
1/1/2004	37987	400	480
1/1/2005	38353	630	810
1/1/2006	38718	406	603
1/1/2007	39083	360	714
1/1/2009	39814	330	570
1/1/2011	40544	520	1100

OU6MW-92		
Date	Date	Benzene Concentration (µg/L)
1/1/2001	36892	74
1/1/2009	39814	90
1/1/2010	40179	59
1/1/2011	40544	39
1/1/2012	40909	6.2

OU6 (LF004)

OU6MW-61		
Date	**Date**	**Benzene Concentration (µg/L)**
1/1/1994	34335	3,140
6/1/1994	34486	3,400
1/1/2010	40179	1,300
1/1/2011	40544	1,100

DP098

41755WL-08					
Date	PCE Concentration (µg/L)	TCE Concentration (µg/L)	cis-DCE Concentration (µg/L)	1,1-DCE Concentration (µg/L)	VC Concentration (µg/L)
1997-2	-	9.96	-	-	-
1999-2	-	22	-	-	-
2000-2	ND (0.12)	30.2	15.6	ND (0.13)	ND (0.13)
2001-2	ND (0.11)	52	15	ND (0.12)	ND (0.22)
2006-1	0.35 J	149	44.9	ND (0.31)	ND (0.31)
2007-1	ND (0.31)	164	67	ND (0.31)	ND (0.31)
2009-1	ND (1)	290	170	0.94 J	ND (1)
2009-2	ND (1)	1	175	0.71 J	ND (1)
2010-1	ND (0.15)	250	160	ND (0.15)	ND (0.25)
2010-2	ND (1.2)	376	286	ND (2.4)	ND (1.6)
2011-1	ND (1)	260	220	0.94	ND (2)
2011-2	ND (0.06)	236	173	0.72	ND (0.08)
2011-3	ND (0.06)	259	200	0.94	ND (0.08)
2012-1	ND (4.5)	280	290	ND (4.5)	ND (4.5)

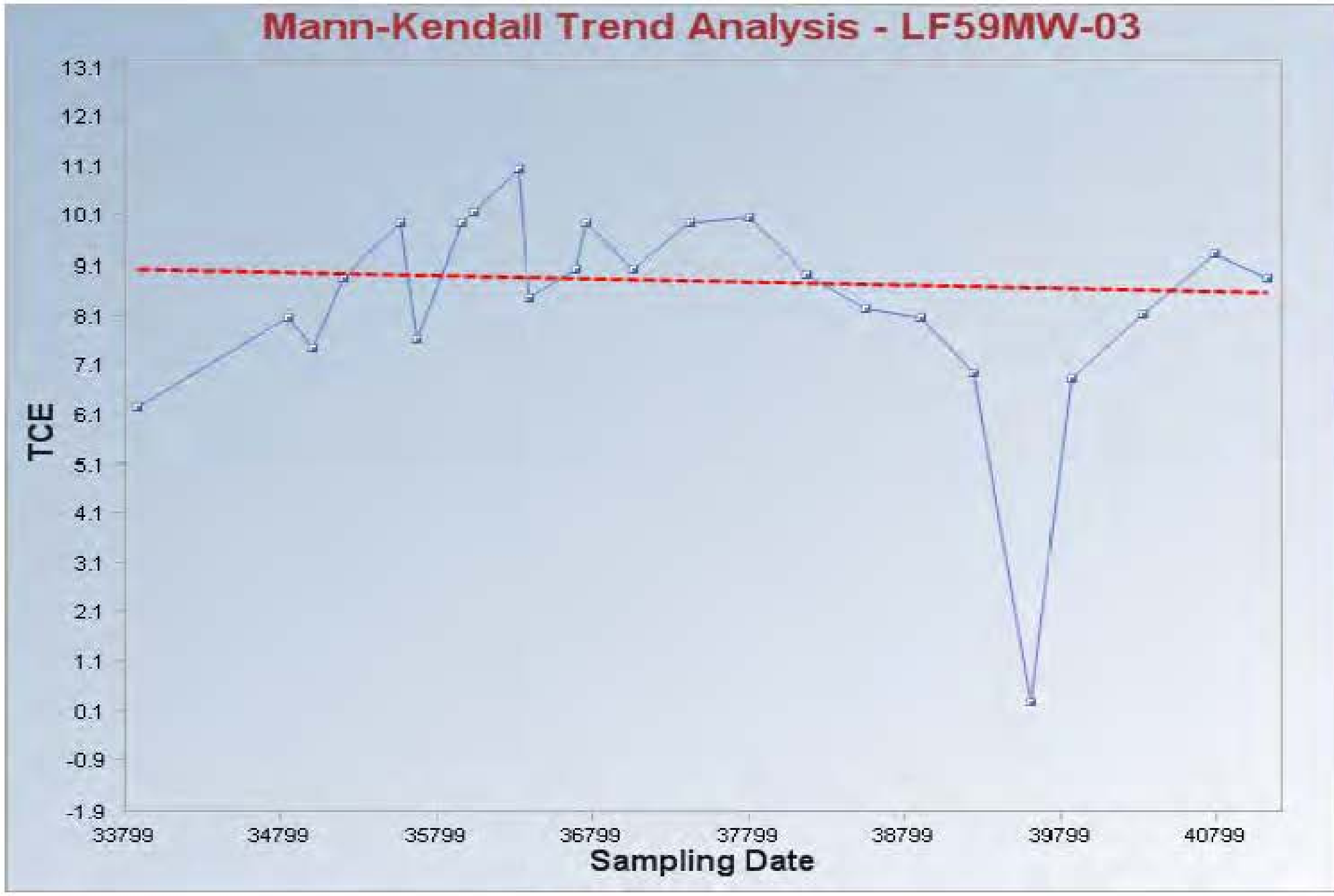
DP98INJ-02				
Date	Date	TCE Concentration (µg/L)	cis-DCE Concentration (µg/L)	Vinyl Chloride Concentration (µg/L)
1/1/2005	38353	4920	6340	-
6/1/2005	38504	1980	4690	-
1/1/2006	38718	-	11100	74
6/1/2006	38869	-	7820	-
1/1/2008	39448	15	11000	200
1/1/2009	39814	0.66	11000	79
1/1/2011	40544	-	8600	260
1/1/2012	40909	1.3	9300	-

41755WL-02				
Date	Date	PCE Concentration (µg/L)	TCE Concentration (µg/L)	cis-DCE Concentration (µg/L)
2/1/1992	33635	2800	2300	4200
2/1/2000	36557	2989	2288	2490
2/1/2001	36923	6400	4400	4000
1/1/2004	37987	1100	1000	2600
1/1/2005	38353	1300	1100	2500
1/1/2006	38718	1240	1870	6370
1/1/2007	39083	1020	1230	2910
1/1/2009	39814	1300	1300	2000
1/1/2010	40179	650	1200	2100
1/1/2011	40544	1300	1100	2900
1/1/2012	40909	450	570	1400

ATTACHMENT G-2

Output Data

OU1 (LF059)



Mann-Kendall Trend Analysis

n	24.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-19
Critical Value (0.05)	-1.6449
Standard Deviation of S	40.1705
Standardized Value of S	-0.4481
Approximate p-value	0.3270

Theil-Sen Trend Line = Red

Theil-Sen Slope	-0.0001
Theil-Sen Intercept	11.0907

Insufficient statistical evidence of a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - LF59MW-03 (TCE)

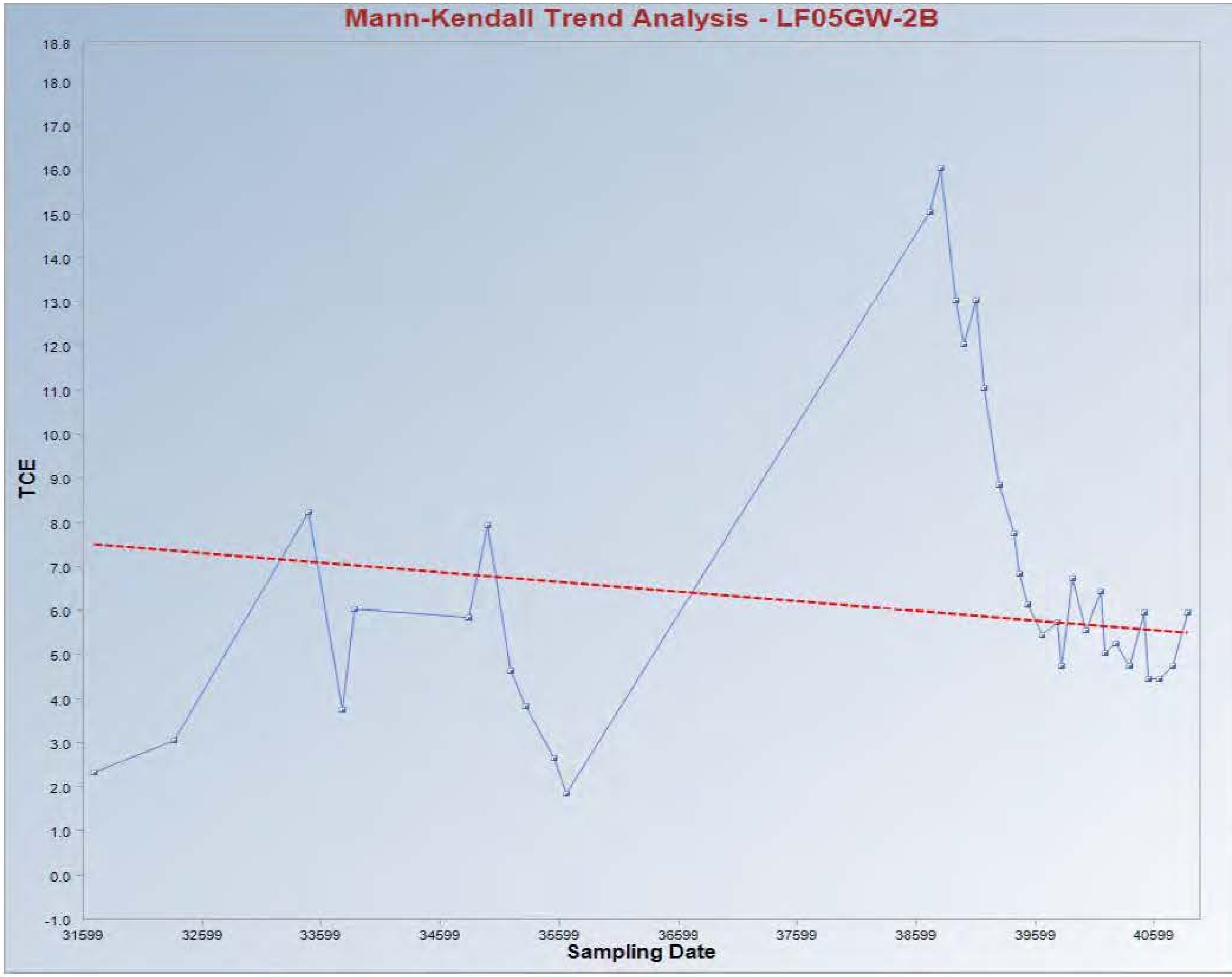
User Selected Options	
Date/Time of Computation	4/8/2013 14:14
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

TCE

General Statistics	
Number of Events	24
Number of Values	24
Minimum	0.22
Maximum	11
Mean	8.347
Geometric Mean	7.394
Median	8.8
Standard Deviation	2.105
SEM	0.43

Mann-Kendall Test	
Test Value (S)	-19
Critical Value (0.05)	-1.645
Standard Deviation of S	40.17
Standardized Value of S	-0.448
Approximate p-value	0.327

Insufficient evidence to identify a significant
trend at the specified level of significance.



Mann-Kendall Trend Analysis

n	35.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-59
Critical Value (0.05)	-1.6449
Standard Deviation of S	70.3681
Standardized Value of S	-0.8242
Approximate p-value	0.2049

Theil-Sen Trend Line = Red

Theil-Sen Slope	-0.0002
Theil-Sen Intercept	14.4072

Insufficient statistical evidence of a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - LF05GW-2B (TCE)

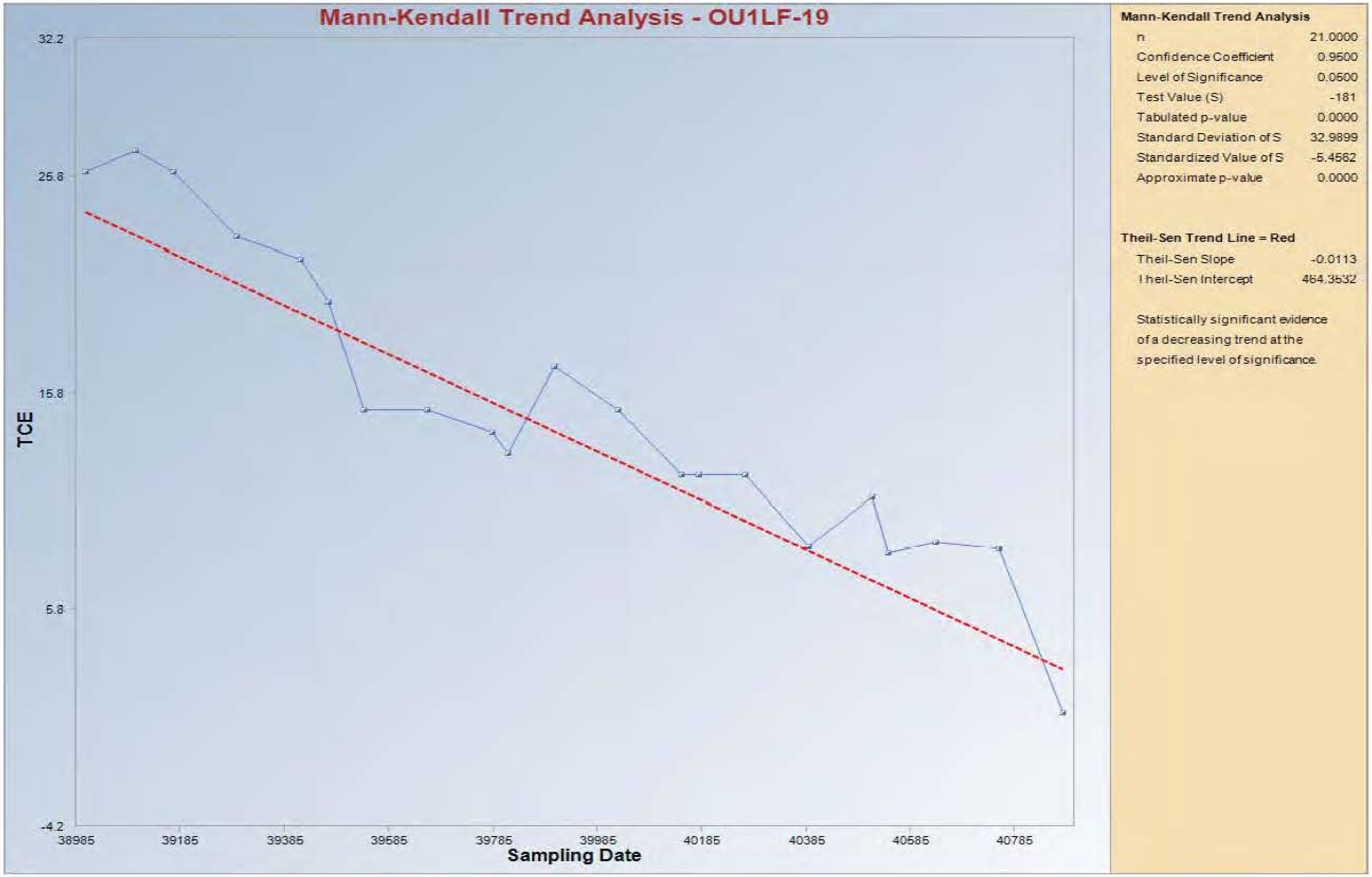
User Selected Options	
Date/Time of Computation	2/3/2014 12:41
From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

TCE

General Statistics	
Number of Events	35
Number of Values	35
Minimum	1.8
Maximum	16
Mean	6.677
Geometric Mean	5.897
Median	5.8
Standard Deviation	3.519
SEM	0.595

Mann-Kendall Test	
Test Value (S)	-59
Critical Value (0.05)	-1.645
Standard Deviation of S	70.37
Standardized Value of S	-0.824
Approximate p-value	0.205

Insufficient evidence to identify a significant


Mann-Kendall Trend Analysis - OU1LF-19
32.2
25.8
15.8
5.8
-4.2
TCE
38985
39185
39385
39585
39785
39985
40185
40385
40585
40785
Sampling Date
Mann-Kendall Trend Analysis
n 21.0000
Confidence Coefficient 0.9500
Level of Significance 0.0500
Test Value (S) -181
Tabulated p-value 0.0000
Standard Deviation of S 32.9899
Standardized Value of S -5.4562
Approximate p-value 0.0000
Theil-Sen Trend Line = Red
Theil-Sen Slope -0.0113
Theil-Sen Intercept 464.3532
Statistically significant evidence
of a decreasing trend at the
specified level of significance.

Mann-Kendall Trend Test Analysis - OU1LF-19 (TCE)

User Selected Options	
Date/Time of Computation	2/3/2014 12:44
From File	WorkSheet_a.wst
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

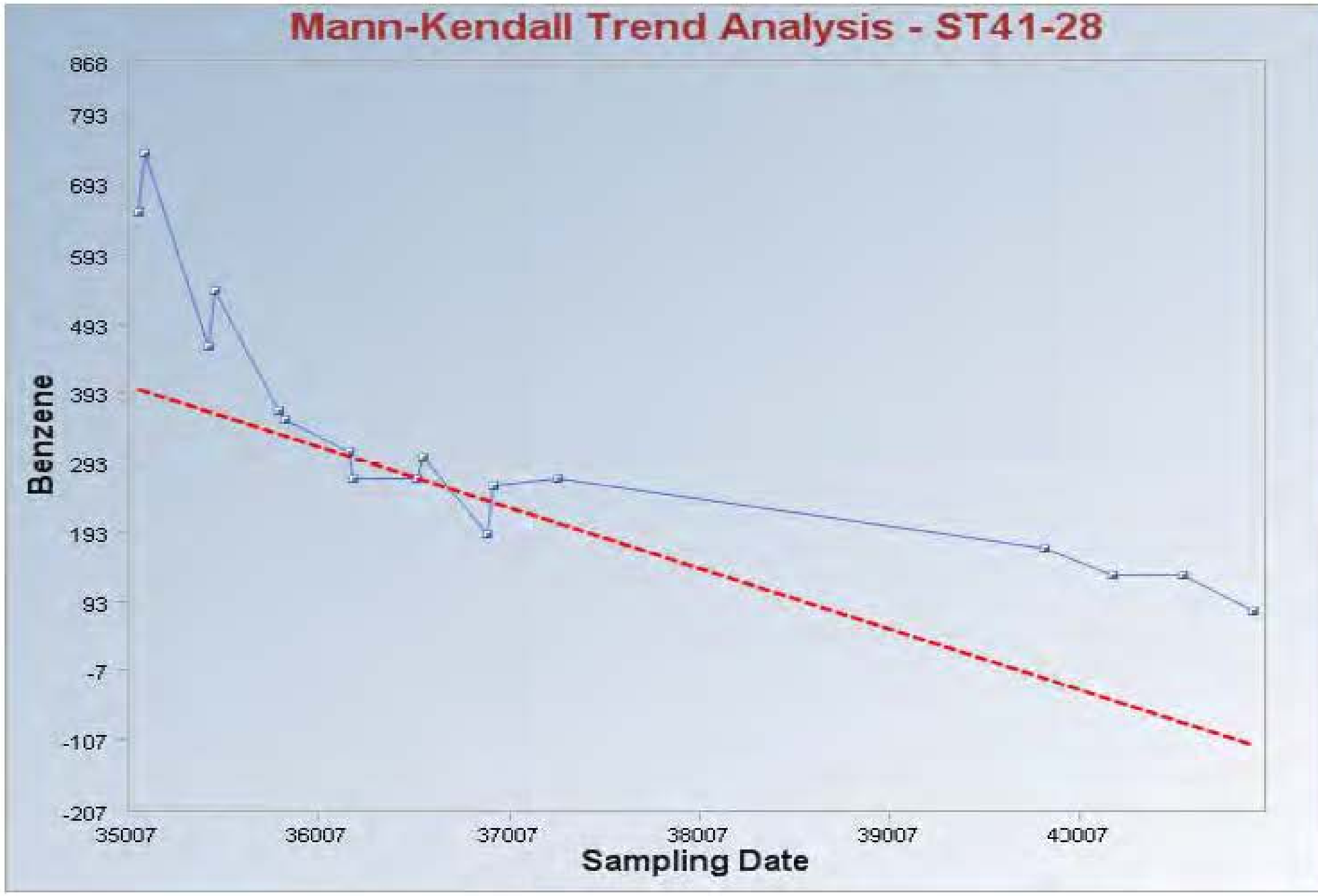
TCE

General Statistics	
Number of Events	21
Number of Values	21
Minimum	1
Maximum	27
Mean	15.03
Geometric Mean	12.89
Median	14
Standard Deviation	6.832
SEM	1.491

Mann-Kendall Test	
Test Value (S)	-181
Tabulated p-value	0
Standard Deviation of S	32.99
Standardized Value of S	-5.456
Approximate p-value	2.43E-08

Statistically significant evidence of a decreasing

OU2 (ST041)



Mann-Kendall Trend Analysis

n	17.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-118
Tabulated p-value	0.0000
Standard Deviation of S	24.1799
Standardized Value of S	-4.8387
Approximate p-value	0.0000

Theil-Sen Trend Line = Red

Theil-Sen Slope	-0.0878
Theil-Sen Intercept	3,477.5908

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - ST41-28 (Benzene)

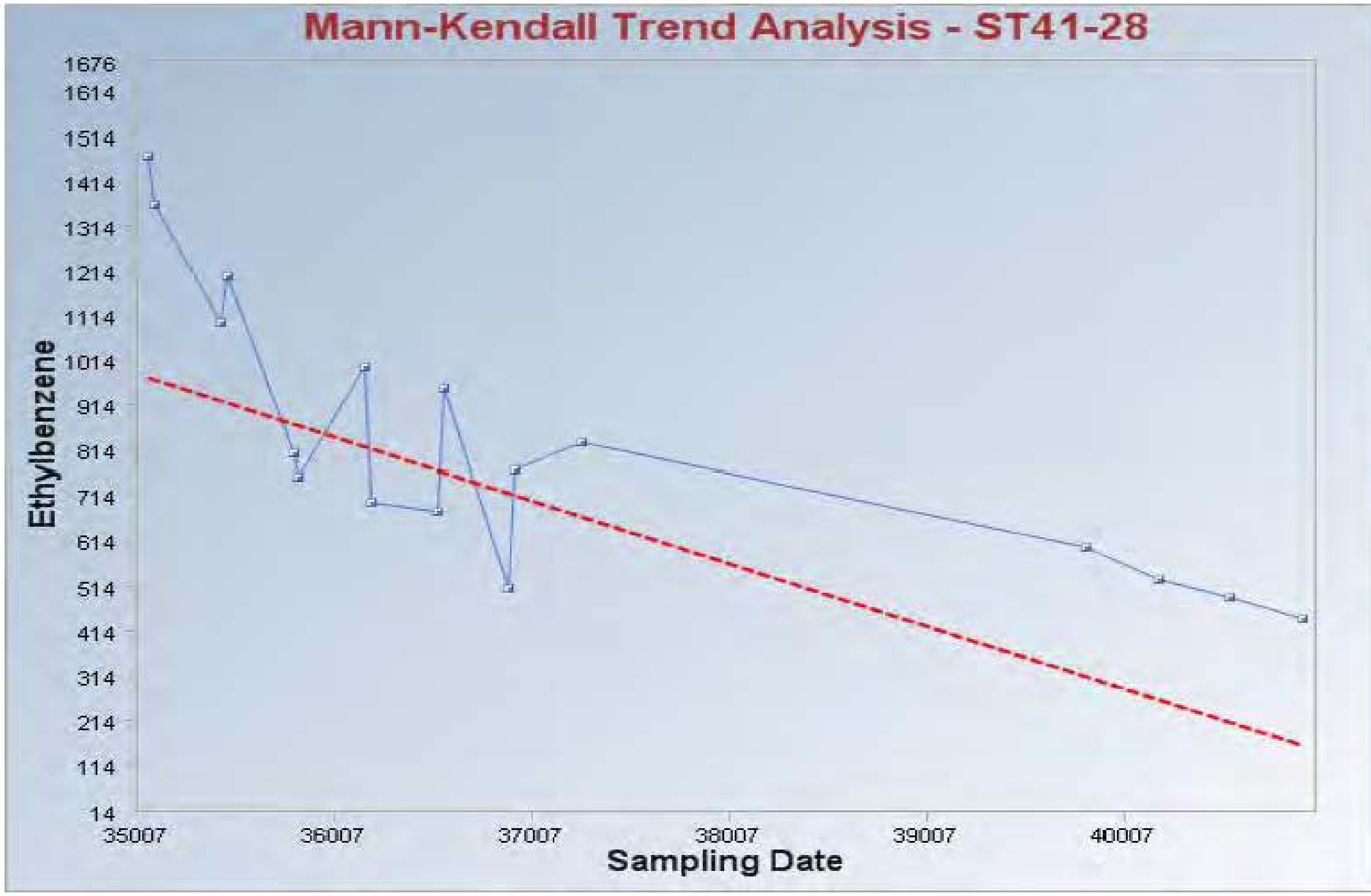
User Selected Options	
Date/Time of Computation	4/8/2013 14:20
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

Benzene

General Statistics	
Number of Events	17
Number of Values	17
Minimum	80
Maximum	737
Mean	323
Geometric Mean	276.5
Median	270
Standard Deviation	183
SEM	44.37

Mann-Kendall Test	
Test Value (S)	-118
Tabulated p-value	0
Standard Deviation of S	24.18
Standardized Value of S	-4.839
Approximate p-value	6.53E-07

Statistically significant evidence of a decreasing
trend at the specified level of significance.



Mann-Kendall Trend Analysis

n	17.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-98
Tabulated p-value	0.0000
Standard Deviation of S	24.2762
Standardized Value of S	-3.9957
Approximate p-value	0.0000

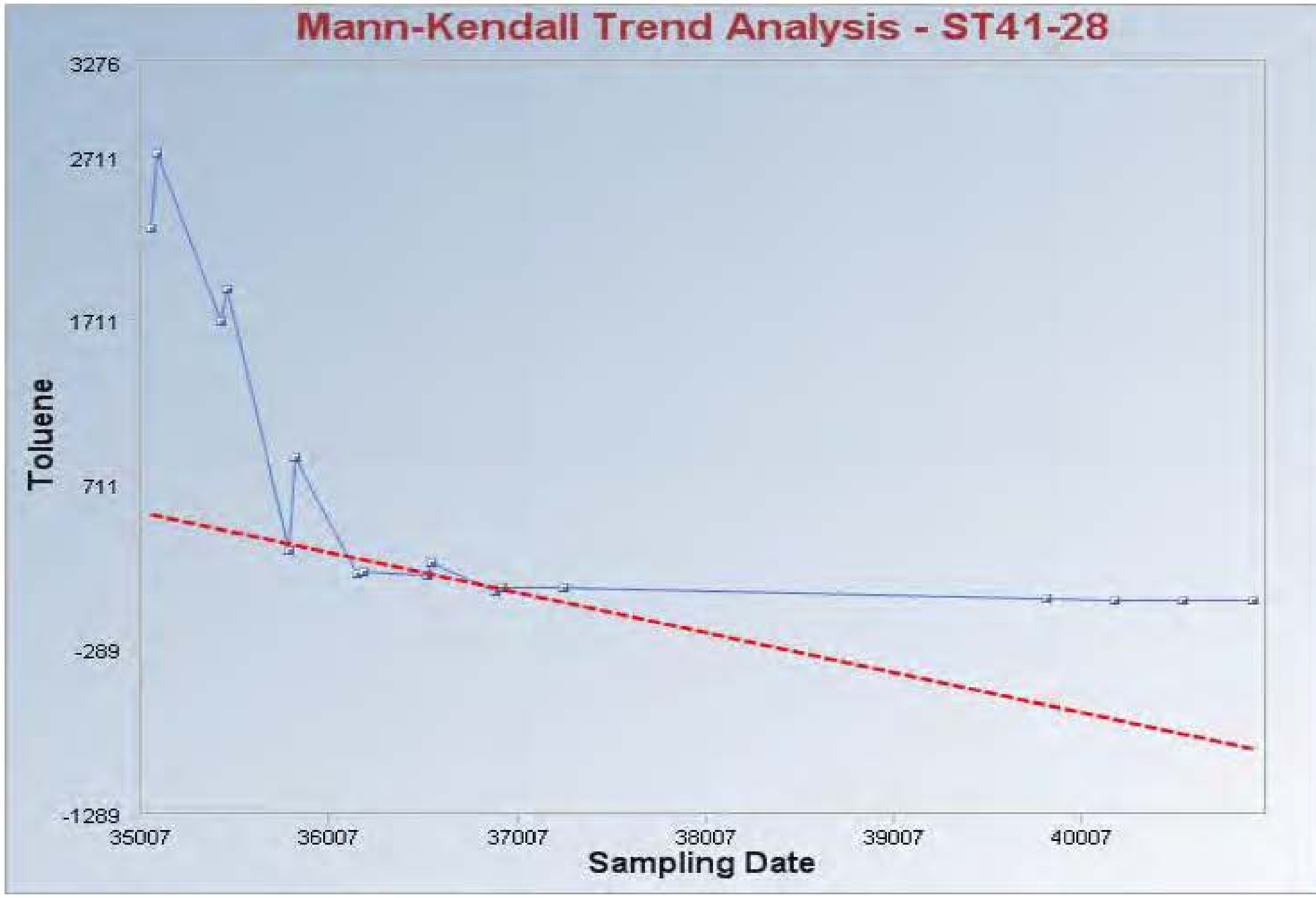
Theil-Sen Trend Line = Red

Theil-Sen Slope	-0.1396
Theil-Sen Intercept	5,869.6710

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - ST41-28 (Ethylbenzene)

User Selected Options	
Date/Time of Computation	4/8/2013 14:23
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05
Ethylbenzene	
General Statistics	
Number of Events	17
Number of Values	17
Minimum	440
Maximum	1470
Mean	834.9
Geometric Mean	784.8
Median	770
Standard Deviation	306.7
SEM	74.39
Mann-Kendall Test	
Test Value (S)	-98
Tabulated p-value	0
Standard Deviation of S	24.28
Standardized Value of S	-3.996
Approximate p-value	3.23E-05



Mann-Kendall Trend Analysis

n	17.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-118
Tabulated p-value	0.0000
Standard Deviation of S	24.2762
Standardized Value of S	-4.8195
Approximate p-value	0.0000

Theil-Sen Trend Line = Red

Theil-Sen Slope	-0.2457
Theil-Sen Intercept	9,142.6976

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis -ST41-28 (Toluene)

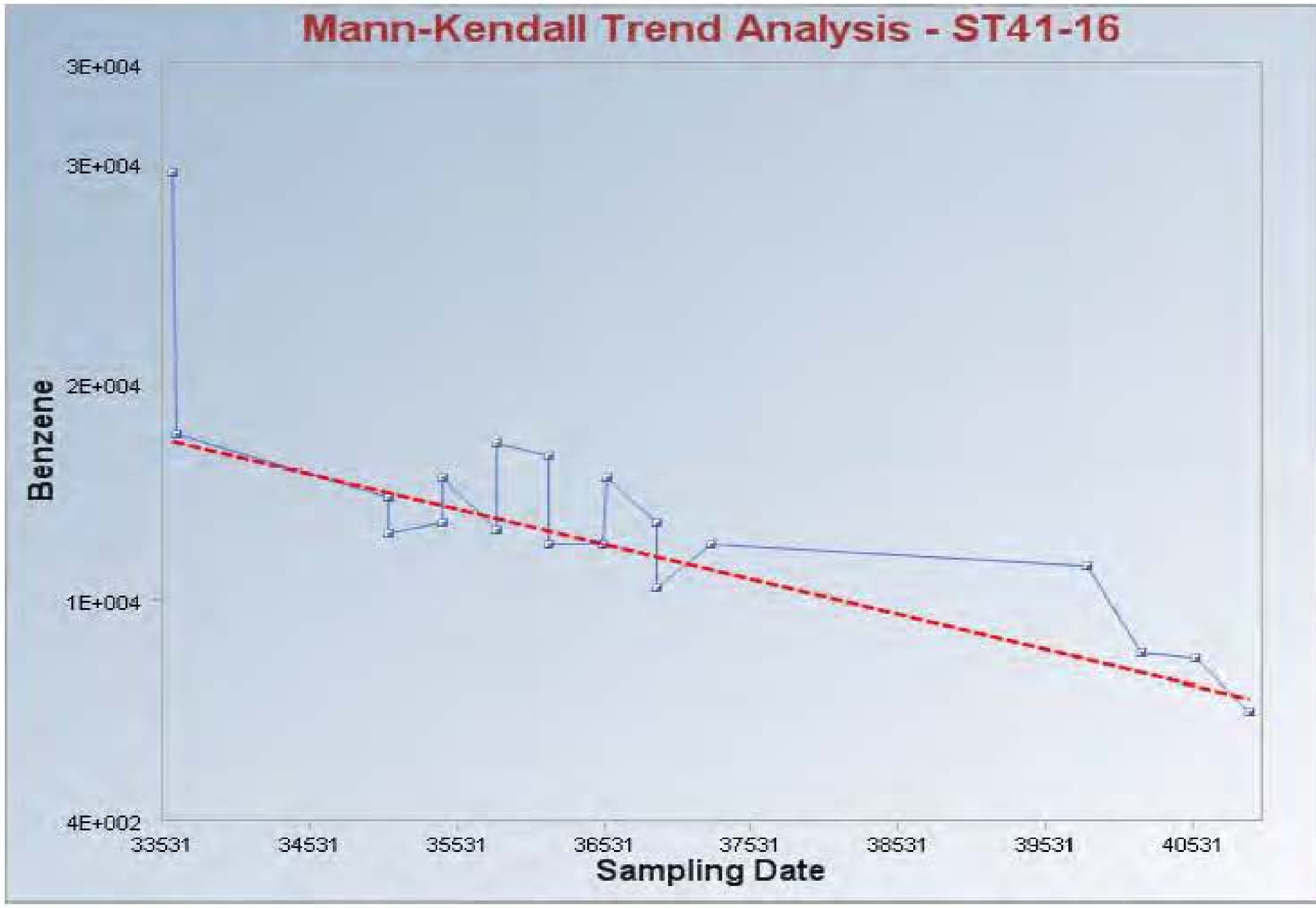
User Selected Options	
Date/Time of Computation	4/25/2013 13:32
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

Toluene

General Statistics	
Number of Events	17
Number of Values	17
Minimum	0.94
Maximum	2730
Mean	633.2
Geometric Mean	128.5
Median	170
Standard Deviation	911.7
SEM	221.1

Mann-Kendall Test	
Test Value (S)	-118
Tabulated p-value	0
Standard Deviation of S	24.28
Standardized Value of S	-4.82
Approximate p-value	7.19E-07

Statistically significant evidence of a decreasing trend at the specified level of significance.



Mann-Kendall Trend Analysis

n	19.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-112
Tabulated p-value	0.0000
Standard Deviation of S	28.4839
Standardized Value of S	-3.8969
Approximate p-value	0.0000

Theil-Sen Trend Line = Red

Theil-Sen Slope	-1.6124
Theil-Sen Intercept	71,908.0621

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - ST41-16 (Benzene)

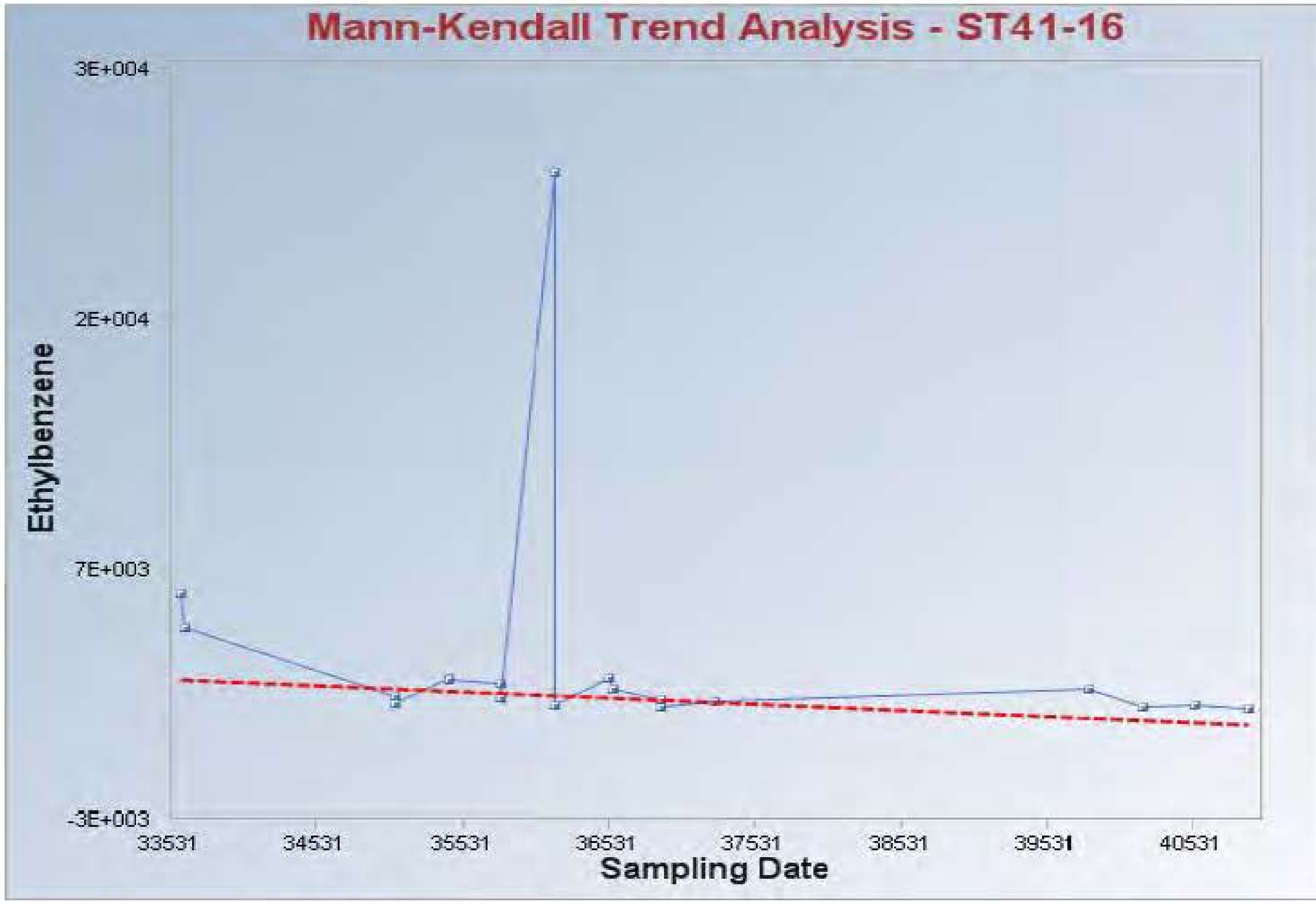
User Selected Options	
Date/Time of Computation	4/8/2013 14:32
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

Benzene

General Statistics	
Number of Events	19
Number of Values	19
Minimum	5300
Maximum	30000
Mean	14095
Geometric Mean	13259
Median	13600
Standard Deviation	5114
SEM	1173

Mann-Kendall Test	
Test Value (S)	-112
Tabulated p-value	0
Standard Deviation of S	28.48
Standardized Value of S	-3.897
Approximate p-value	4.87E-05

Statistically significant evidence of a decreasing
trend at the specified level of significance.



Mann-Kendall Trend Analysis

n	19.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-89
Tabulated p-value	0.0010
Standard Deviation of S	28.5132
Standardized Value of S	-3.0863
Approximate p-value	0.0010

Theil-Sen Trend Line = Red

Theil-Sen Slope	-0.2516
Theil-Sen Intercept	11,059.8468

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - ST41-16 (Ethylbenzene)

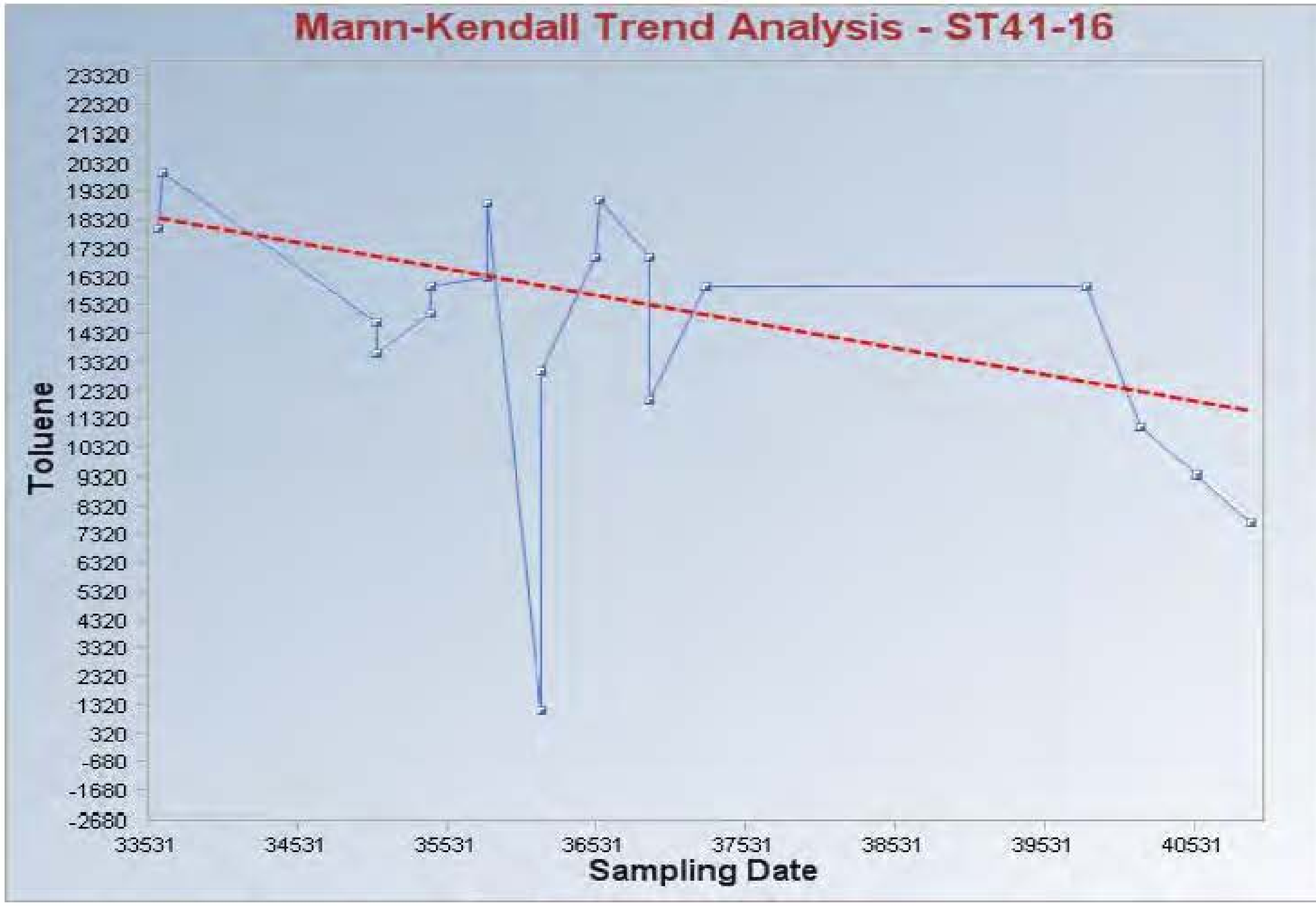
User Selected Options	
Date/Time of Computation	4/8/2013 14:33
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

Ethylbenzene

General Statistics	
Number of Events	19
Number of Values	19
Minimum	1400
Maximum	23000
Mean	3434
Geometric Mean	2436
Median	1960
Standard Deviation	4883
SEM	1120

Mann-Kendall Test	
Test Value (S)	-89
Tabulated p-value	0.001
Standard Deviation of S	28.51
Standardized Value of S	-3.086
Approximate p-value	1.01E-03

Statistically significant evidence of a decreasing
trend at the specified level of significance.



Mann-Kendall Trend Analysis

n	19.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-53
Tabulated p-value	0.0340
Standard Deviation of S	28.5015
Standardized Value of S	-1.8245
Approximate p-value	0.0340

Theil-Sen Trend Line = Red

Theil-Sen Slope	-0.9211
Theil-Sen Intercept	49,308.5662

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - ST41-16 (Toluene)

User Selected Options	
Date/Time of Computation	4/8/2013 14:34
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

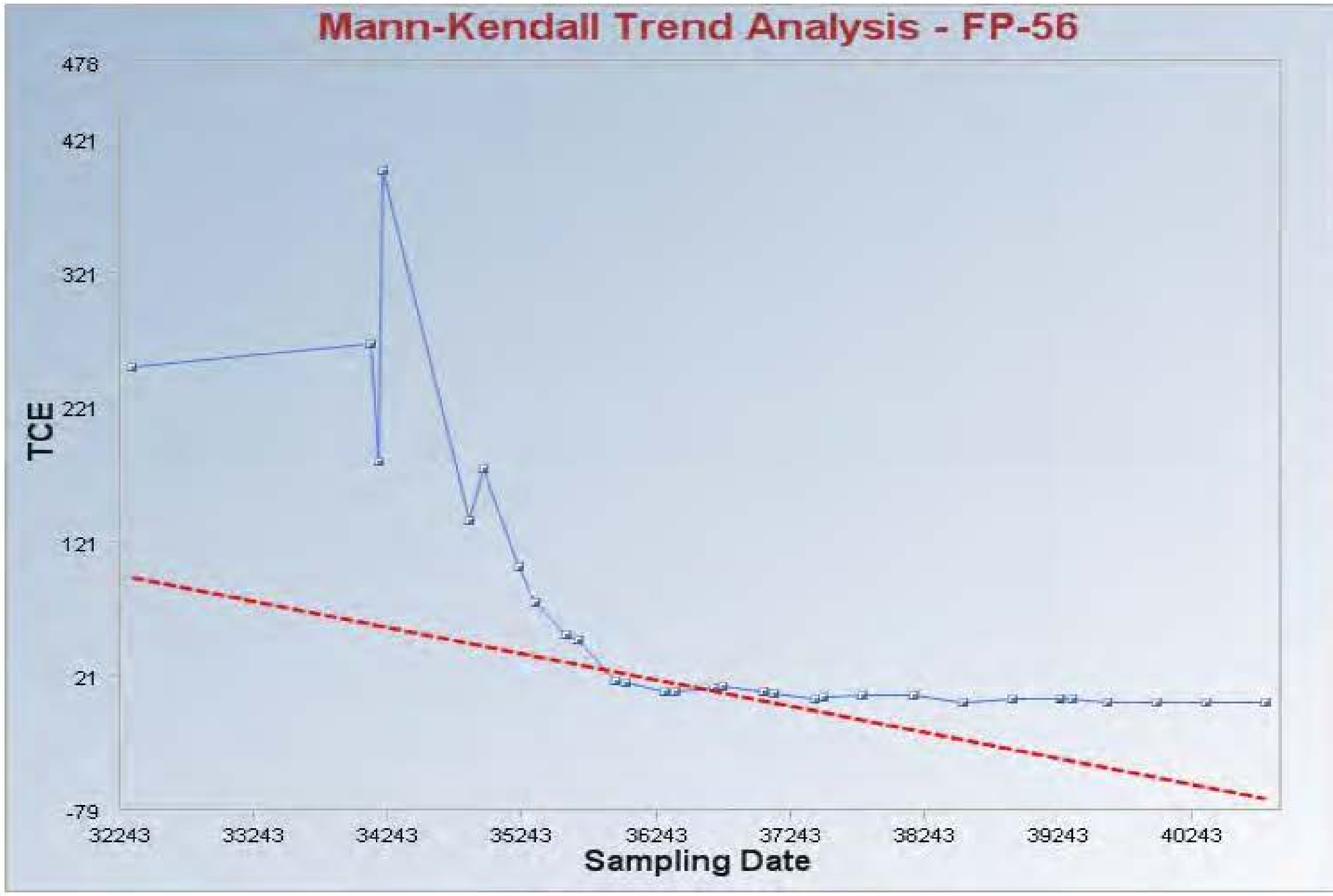
Toluene

General Statistics	
Number of Events	19
Number of Values	19
Minimum	1100
Maximum	20000
Mean	14300
Geometric Mean	12757
Median	16000
Standard Deviation	4580
SEM	1051

Mann-Kendall Test	
Test Value (S)	-53
Tabulated p-value	0.034
Standard Deviation of S	28.5
Standardized Value of S	-1.824
Approximate p-value	0.034

Statistically significant evidence of a decreasing
trend at the specified level of significance.

OU4 (FT023)



Mann-Kendall Trend Analysis

n	30.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-386
Critical Value (0.05)	-1.6449
Standard Deviation of S	56.0417
Standardized Value of S	-6.8699
Approximate p-value	0.0000

Theil-Sen Trend Line = Red

Theil-Sen Slope	-0.0195
Theil-Sen Intercept	724.6451

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - FP-56 (TCE)

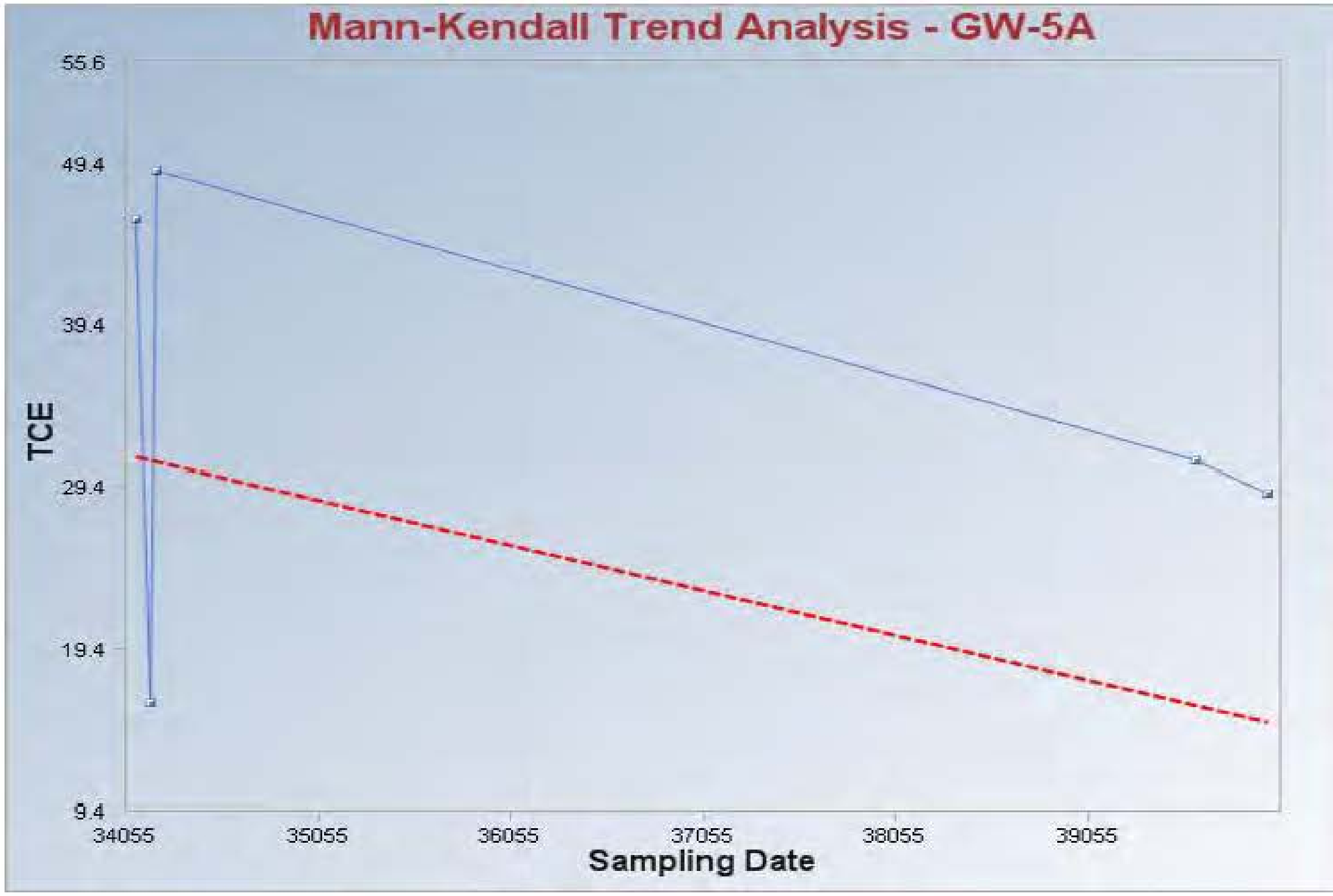
User Selected Options	
Date/Time of Computation	4/8/2013 14:36
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

TCE

General Statistics	
Number of Events	30
Number of Values	30
Minimum	0.2
Maximum	398
Mean	60.2
Geometric Mean	12.33
Median	8.7
Standard Deviation	99.58
SEM	18.18

Mann-Kendall Test	
Test Value (S)	-386
Critical Value (0.05)	-1.645
Standard Deviation of S	56.04
Standardized Value of S	-6.87
Approximate p-value	3.21E-12

Statistically significant evidence of a decreasing trend at the specified level of significance.



Mann-Kendall Trend Analysis

n	5.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-2
Tabulated p-value	0.4080
Standard Deviation of S	4.0825
Standardized Value of S	-0.2449
Approximate p-value	0.4032

Theil-Sen Trend Line = Red

Theil-Sen Slope	-0.0028
Theil-Sen Intercept	127.2439

Insufficient statistical evidence of a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - GW-5A (TCE)

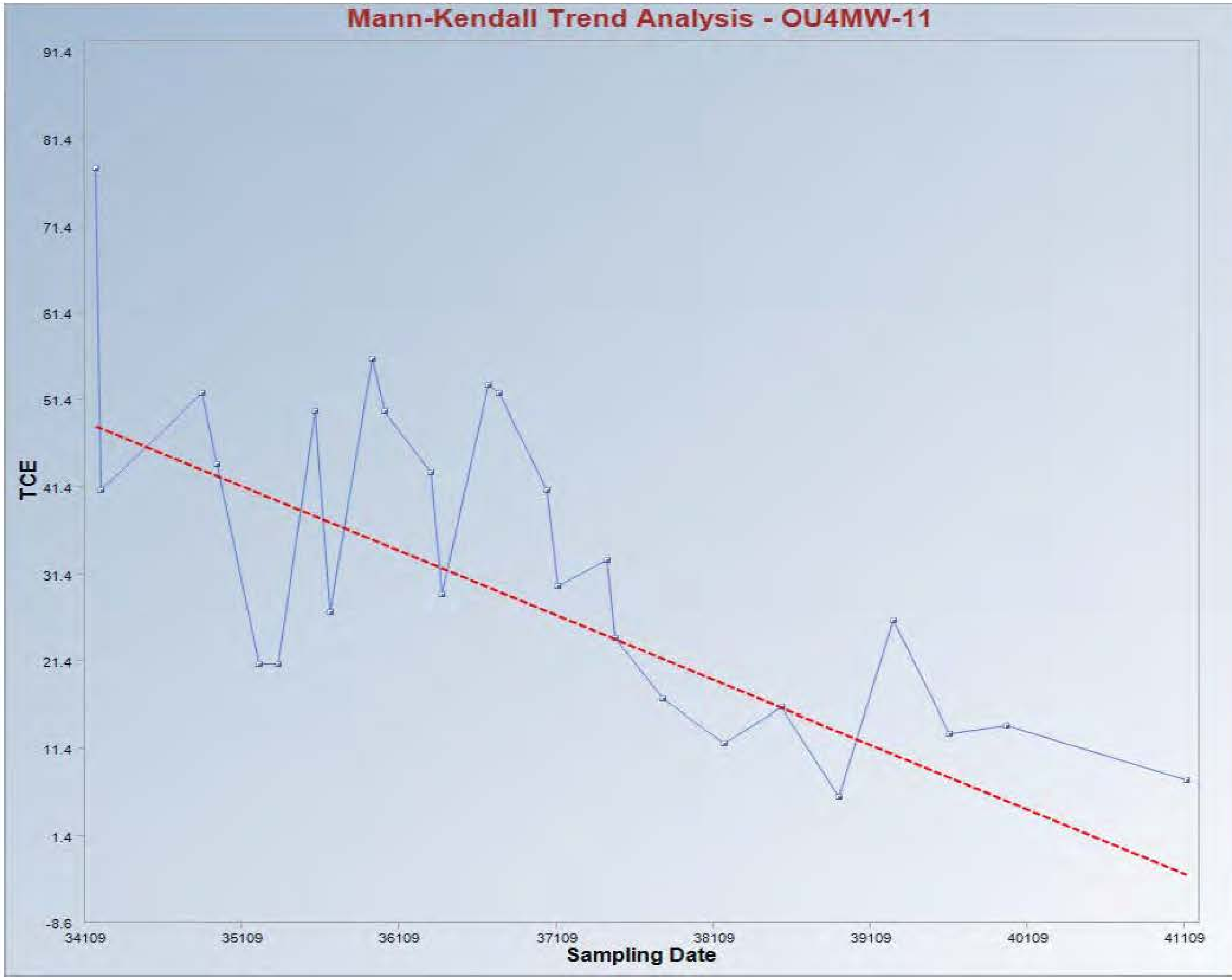
User Selected Options	
Date/Time of Computation	4/8/2013 14:37
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

TCE

General Statistics	
Number of Events	5
Number of Values	5
Minimum	16
Maximum	49
Mean	34.2
Geometric Mean	31.78
Median	31
Standard Deviation	13.48
SEM	6.028

Mann-Kendall Test	
Test Value (S)	-2
Tabulated p-value	0.408
Standard Deviation of S	4.082
Standardized Value of S	-0.245
Approximate p-value	0.403

Insufficient evidence to identify a significant trend at the specified level of significance.



Mann-Kendall Trend Analysis

n	26.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-171
Critical Value (0.05)	-1.6449
Standard Deviation of S	45.3248
Standardized Value of S	-3.7507
Approximate p-value	0.0001

Theil-Sen Trend Line = Red

Theil-Sen Slope	-0.0074
Theil-Sen Intercept	302.1213

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - OU4MW-11 (TCE)

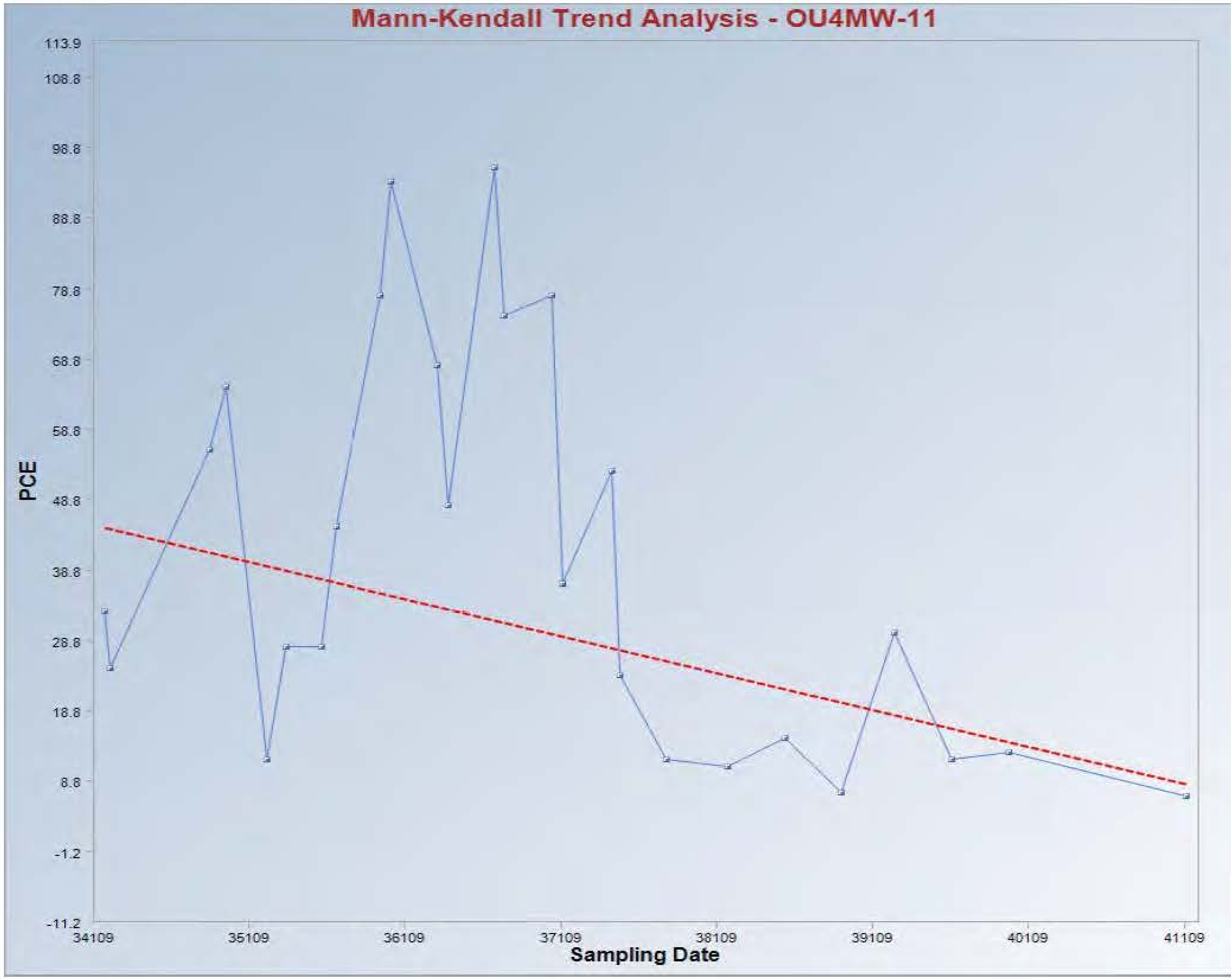
User Selected Options	
Date/Time of Computation	4/8/2013 15:00
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

TCE

General Statistics	
Number of Events	26
Number of Values	26
Minimum	6.7
Maximum	96
Mean	40.38
Geometric Mean	30.42
Median	31.5
Standard Deviation	28.1
SEM	5.51

Mann-Kendall Test	
Test Value (S)	-98
Critical Value (0.05)	-1.645
Standard Deviation of S	45.31
Standardized Value of S	-2.141
Approximate p-value	0.0161

Statistically significant evidence of a decreasing
trend at the specified level of significance.



Mann-Kendall Trend Analysis

n	26.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-98
Critical Value (0.05)	-1.6449
Standard Deviation of S	45.3064
Standardized Value of S	-2.1410
Approximate p-value	0.0161

Theil-Sen Trend Line = Red

Theil-Sen Slope	-0.0052
Theil-Sen Intercept	223.8406

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - OU4MW-11 (PCE)

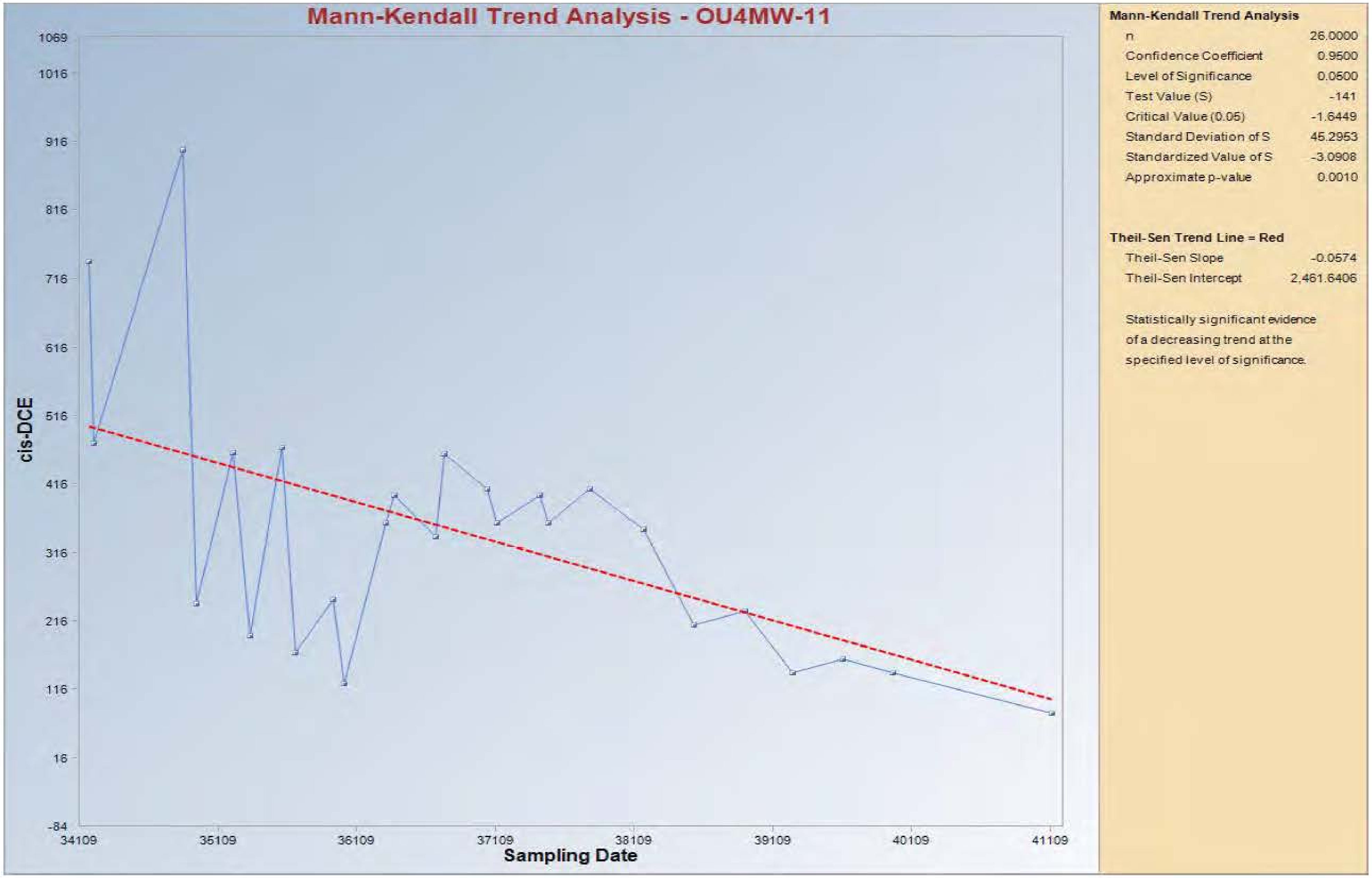
User Selected Options	
Date/Time of Computation	4/8/2013 15:02
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

PCE

General Statistics	
Number of Events	26
Number of Values	26
Minimum	5.8
Maximum	78
Mean	32.94
Geometric Mean	27.57
Median	29.5
Standard Deviation	18.12
SEM	3.554

Mann-Kendall Test	
Test Value (S)	-171
Critical Value (0.05)	-1.645
Standard Deviation of S	45.32
Standardized Value of S	-3.751
Approximate p-value	8.82E-05

Statistically significant evidence of a decreasing trend at the specified level of significance.


Mann-Kendall Trend Analysis - OU4MW-11
cis-DCE
Sampling Date
1069
1016
916
816
716
616
516
416
316
216
116
16
-84
34109
35109
36109
37109
38109
39109
40109
41109
Mann-Kendall Trend Analysis
n 26.0000
Confidence Coefficient 0.9500
Level of Significance 0.0500
Test Value (S) -141
Critical Value (0.05) -1.6449
Standard Deviation of S 45.2953
Standardized Value of S -3.0908
Approximate p-value 0.0010
Theil-Sen Trend Line = Red
Theil-Sen Slope -0.0574
Theil-Sen Intercept 2,461.6406
Statistically significant evidence
of a decreasing trend at the
specified level of significance.

Mann-Kendall Trend Test Analysis - OU4MW-11 (cis-1,2-DCE)

User Selected Options	
Date/Time of Computation	4/8/2013 15:03
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

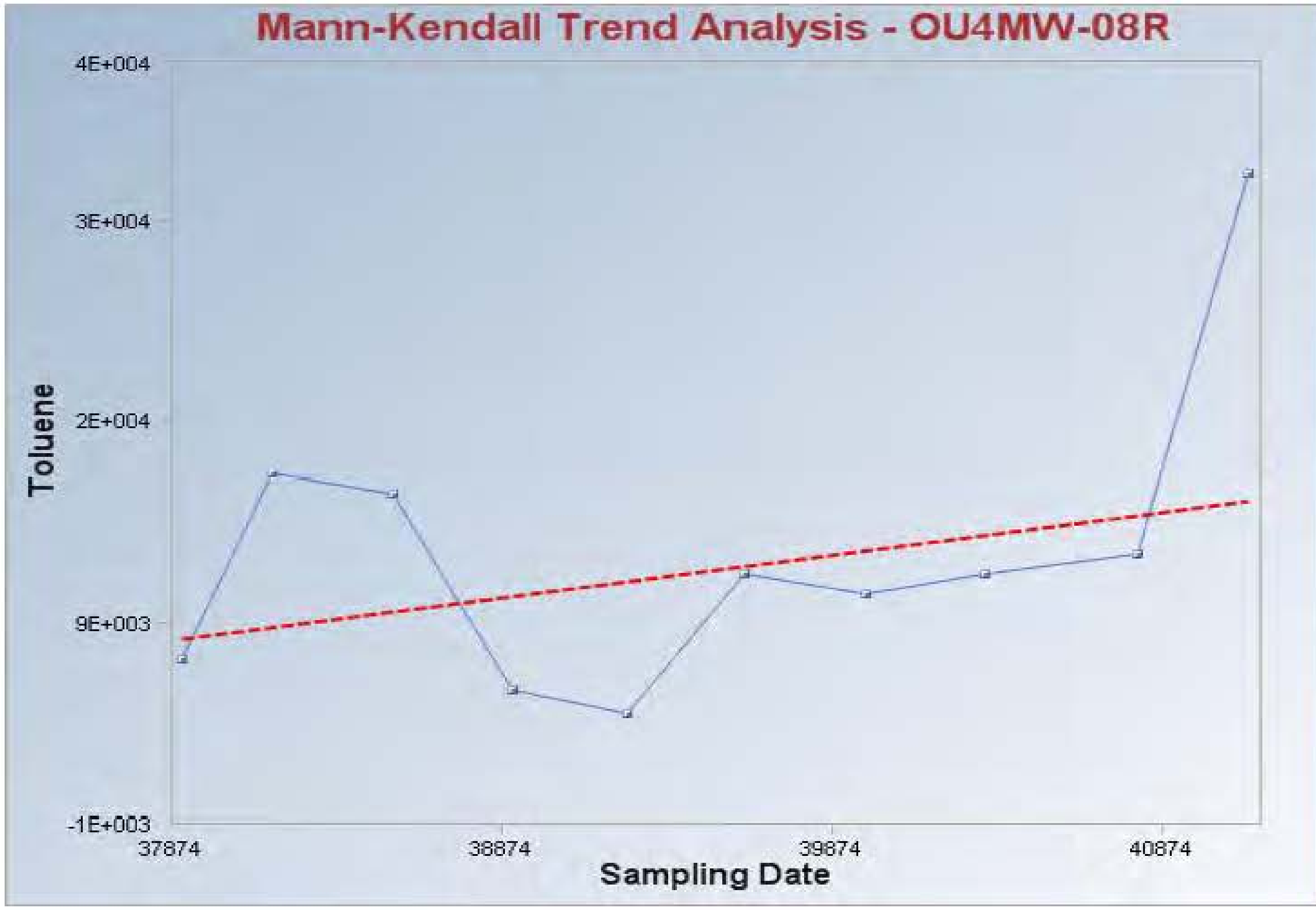
cis-1,2-DCE

General Statistics	
Number of Events	26
Number of Values	26
Minimum	81
Maximum	904
Mean	340.1
Geometric Mean	293.5
Median	355
Standard Deviation	188.1
SEM	36.9

Mann-Kendall Test	
Test Value (S)	-141
Critical Value (0.05)	-1.645
Standard Deviation of S	45.3
Standardized Value of S	-3.091
Approximate p-value	0.000998

Statistically significant evidence of a decreasing
trend at the specified level of significance.

OU4 (SD025)



Mann-Kendall Trend Analysis

n	10.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	10
Tabulated p-value	0.1900
Standard Deviation of S	11.1355
Standardized Value of S	0.8082
Approximate p-value	0.2095

Theil-Sen Trend Line = Red

Theil-Sen Slope	2.1505
Theil-Sen Intercept	-73,796.7742

Insufficient statistical evidence of a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - OU4MW-08R (Toluene)

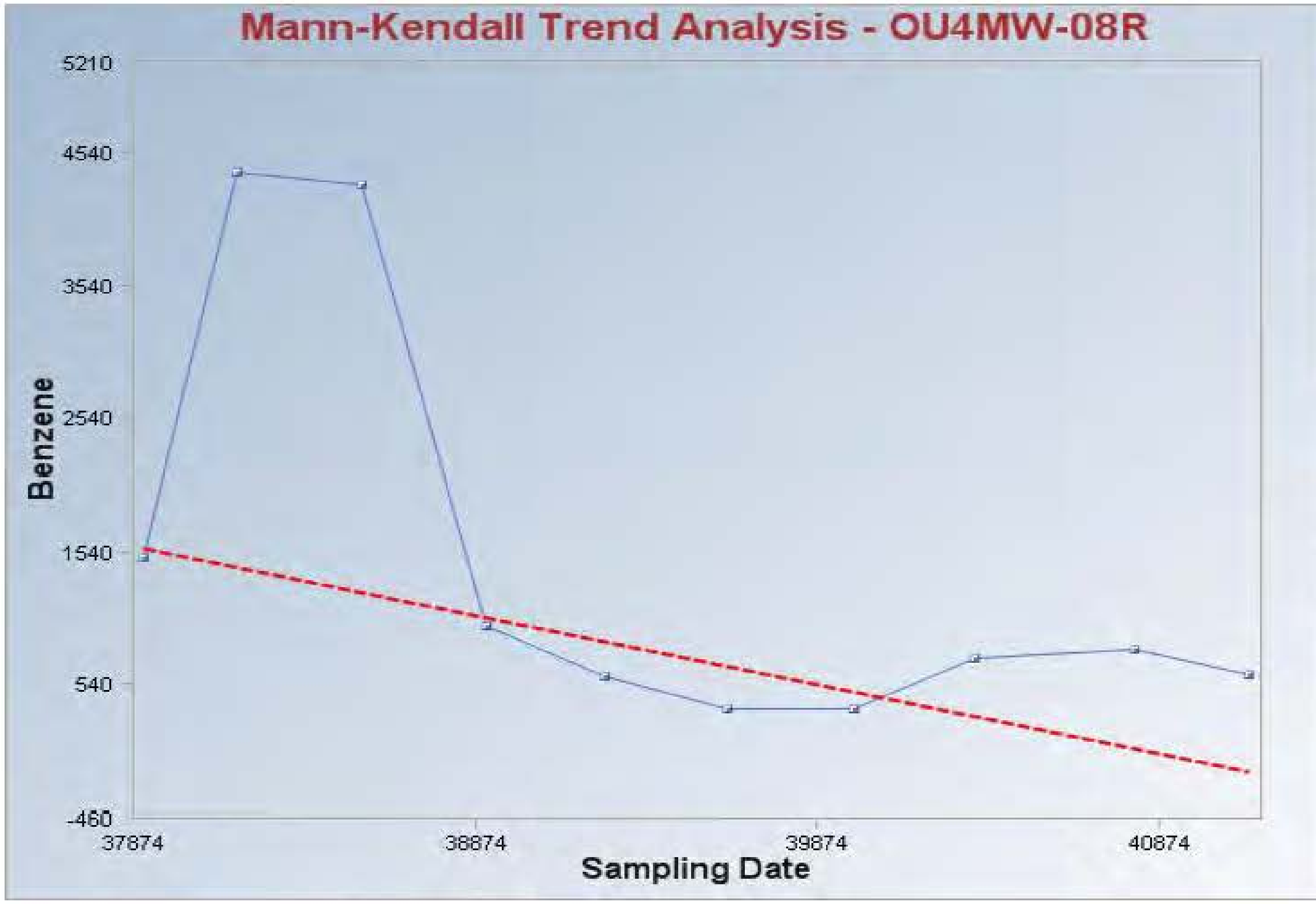
User Selected Options	
Date/Time of Computation	4/9/2013 16:06
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

Toluene

General Statistics	
Number of Events	10
Number of Values	10
Minimum	4000
Maximum	31000
Mean	12200
Geometric Mean	10433
Median	11000
Standard Deviation	7666
SEM	2424

Mann-Kendall Test	
Test Value (S)	10
Tabulated p-value	0.19
Standard Deviation of S	11.14
Standardized Value of S	0.808
Approximate p-value	0.209

Insufficient evidence to identify a significant
trend at the specified level of significance.



Mann-Kendall Trend Analysis

n	10.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-19
Tabulated p-value	0.0540
Standard Deviation of S	11.1803
Standardized Value of S	-1.6100
Approximate p-value	0.0537

Theil-Sen Trend Line = Red

Theil-Sen Slope	-0.5190
Theil-Sen Intercept	21,232.9341

Insufficient statistical evidence of a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - OU4MW-08R (Benzene)

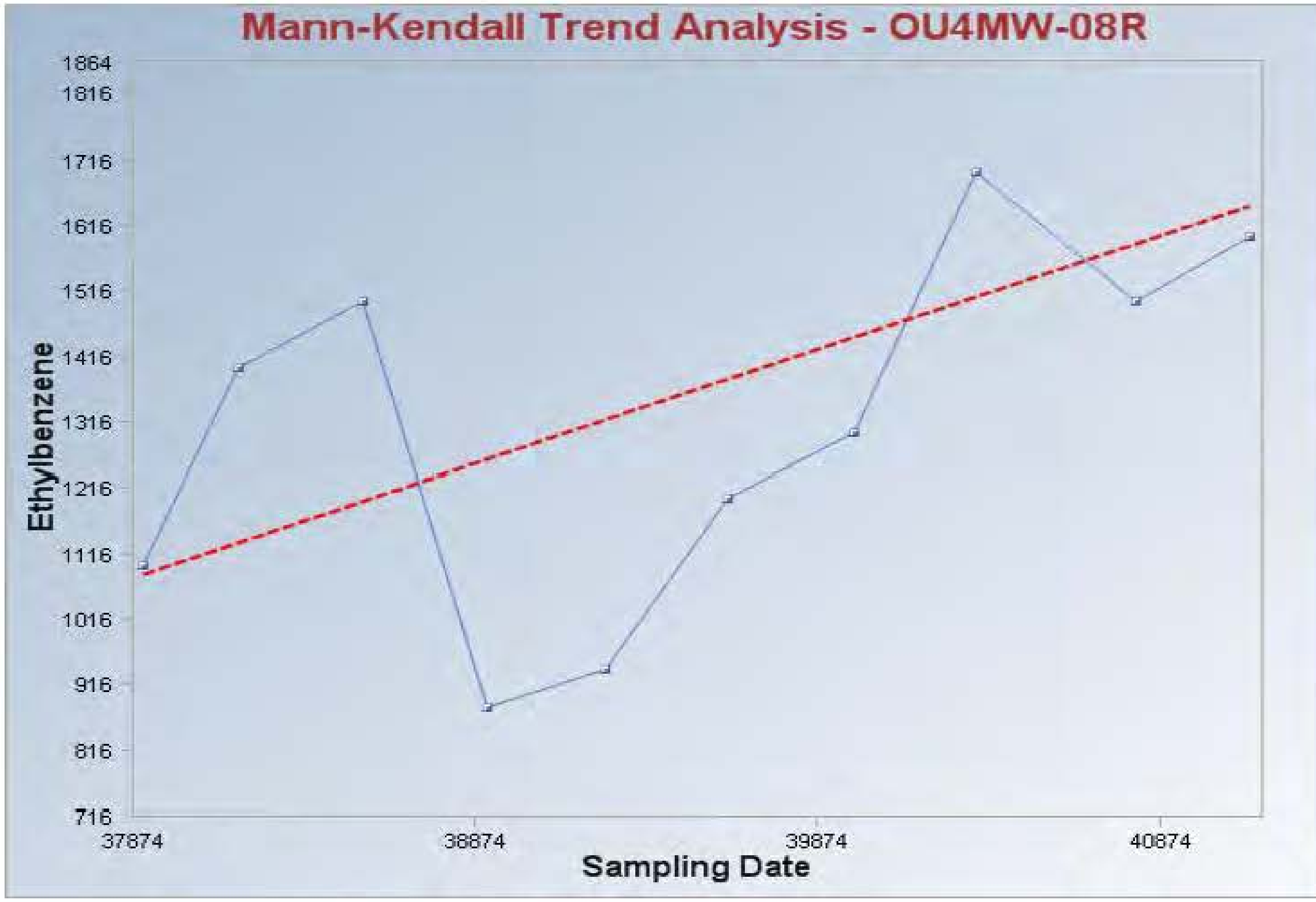
User Selected Options	
Date/Time of Computation	4/9/2013 16:07
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

Benzene

General Statistics	
Number of Events	10
Number of Values	10
Minimum	350
Maximum	4400
Mean	1464
Geometric Mean	972.8
Median	770
Standard Deviation	1556
SEM	492.2

Mann-Kendall Test	
Test Value (S)	-19
Tabulated p-value	0.054
Standard Deviation of S	11.18
Standardized Value of S	-1.61
Approximate p-value	0.0537

Insufficient evidence to identify a significant trend at the specified level of significance.



Mann-Kendall Trend Analysis

n	10.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	20
Tabulated p-value	0.0360
Standard Deviation of S	11.1355
Standardized Value of S	1.7063
Approximate p-value	0.0440

Theil-Sen Trend Line = Red

Theil-Sen Slope	0.1744
Theil-Sen Intercept	-5,527.4128

Statistically significant evidence of an increasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - OU4MW-08R (Ethylbenzene)

User Selected Options	
Date/Time of Computation	4/9/2013 16:08
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

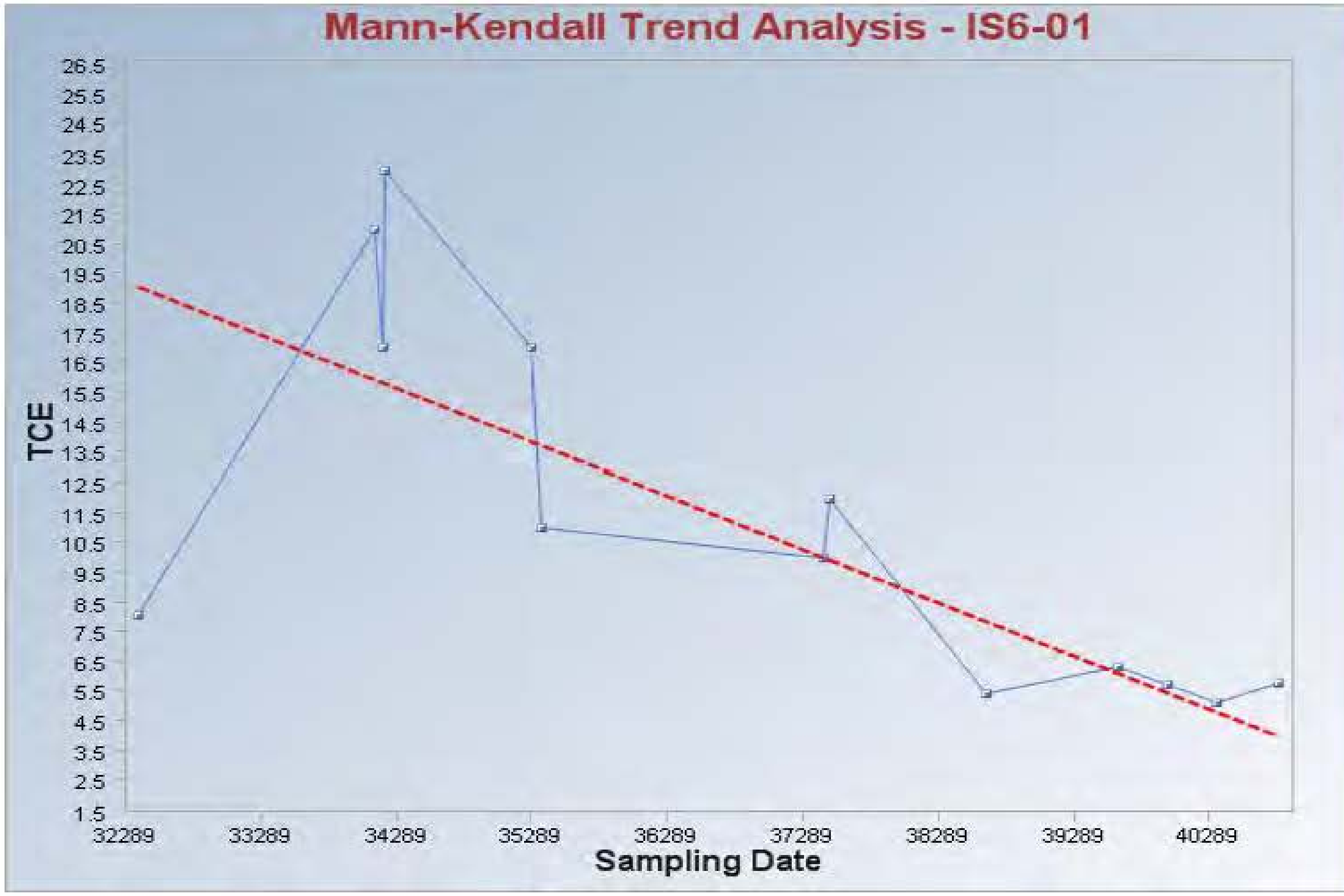
Ethylbenzene

General Statistics	
Number of Events	10
Number of Values	10
Minimum	880
Maximum	1700
Mean	1312
Geometric Mean	1284
Median	1350
Standard Deviation	277.8
SEM	87.85

Mann-Kendall Test	
Test Value (S)	20
Tabulated p-value	0.036
Standard Deviation of S	11.14
Standardized Value of S	1.706
Approximate p-value	0.044

Statistically significant evidence of an increasing
trend at the specified level of significance.

OU4 (SD029)



Mann-Kendall Trend Analysis

n	13.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-45
Tabulated p-value	0.0030
Standard Deviation of S	16.3605
Standardized Value of S	-2.6894
Approximate p-value	0.0036

Theil-Sen Trend Line = Red

Theil-Sen Slope	-0.0018
Theil-Sen Intercept	76.9710

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - IS6-01 (TCE)

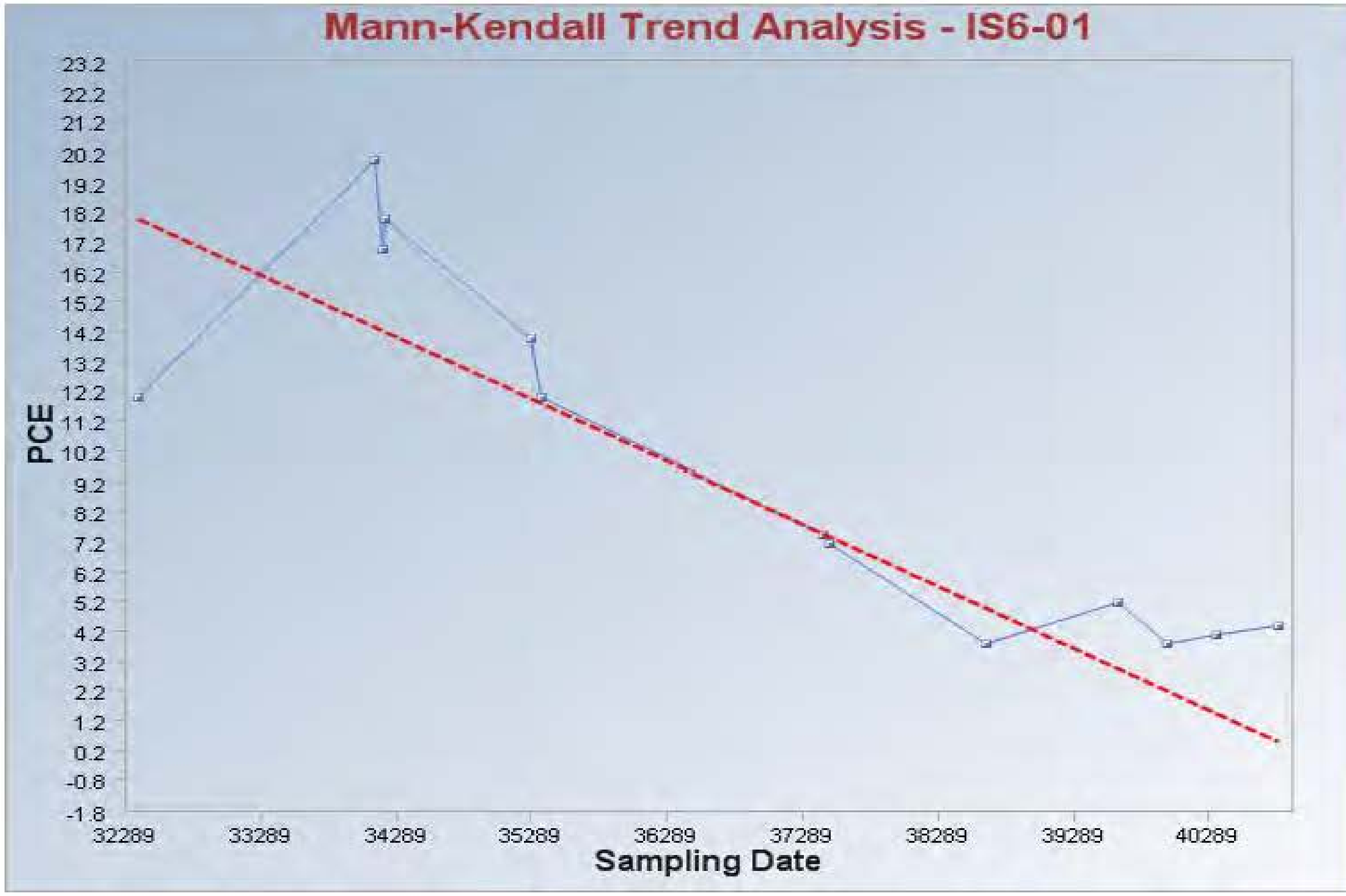
User Selected Options		
Date/Time of Computation	4/9/2013 16:20	
Full Precision	OFF	
Confidence Coefficient	0.95	
Level of Significance	0.05	

TCE

General Statistics	
Number of Events	13
Number of Values	13
Minimum	5.1
Maximum	23
Mean	11.34
Geometric Mean	9.881
Median	10
Standard Deviation	6.247
SEM	1.733

Mann-Kendall Test	
Test Value (S)	-45
Tabulated p-value	0.003
Standard Deviation of S	16.36
Standardized Value of S	-2.689
Approximate p-value	0.00358

Statistically significant evidence of a decreasing trend at the specified level of significance.



Mann-Kendall Trend Analysis

n	13.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-54
Tabulated p-value	0.0000
Standard Deviation of S	16.3299
Standardized Value of S	-3.2456
Approximate p-value	0.0006

Theil-Sen Trend Line = Red

Theil-Sen Slope	-0.0021
Theil-Sen Intercept	85.2613

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - IS6-01 (PCE)

User Selected Options	
Date/Time of Computation	4/9/2013 16:21
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

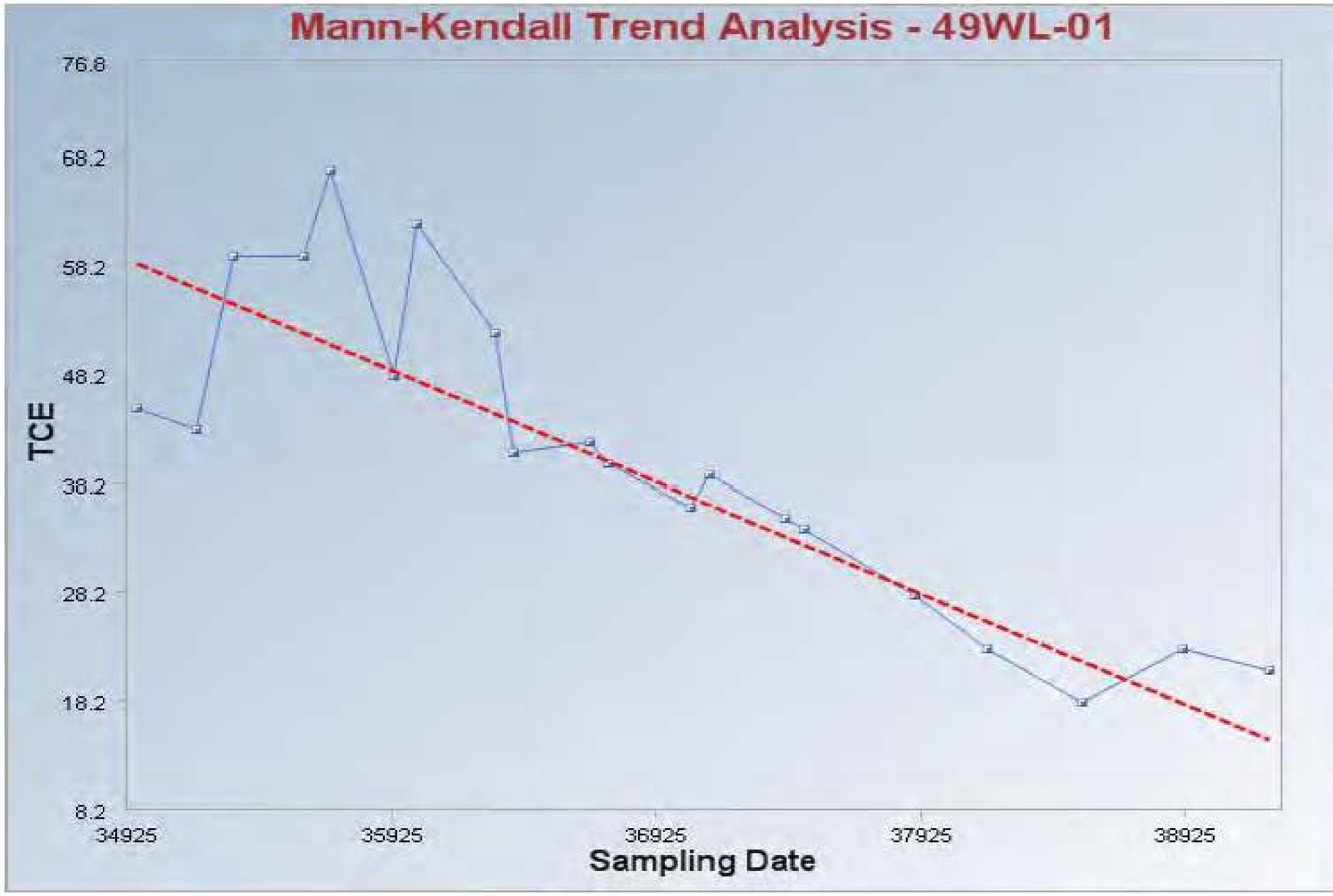
PCE

General Statistics	
Number of Events	13
Number of Values	13
Minimum	3.8
Maximum	20
Mean	9.923
Geometric Mean	8.311
Median	7.5
Standard Deviation	5.896
SEM	1.635

Mann-Kendall Test	
Test Value (S)	-54
Tabulated p-value	0
Standard Deviation of S	16.33
Standardized Value of S	-3.246
Approximate p-value	5.86E-04

Statistically significant evidence of a decreasing
trend at the specified level of significance.

OU5 (Fairchild Plume)



Mann-Kendall Trend Analysis

n	20.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-144
Tabulated p-value	0.0000
Standard Deviation of S	30.7896
Standardized Value of S	-4.6444
Approximate p-value	0.0000

Theil-Sen Trend Line = Red

Theil-Sen Slope	-0.0102
Theil-Sen Intercept	416.1615

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - 49WL-01 (TCE)

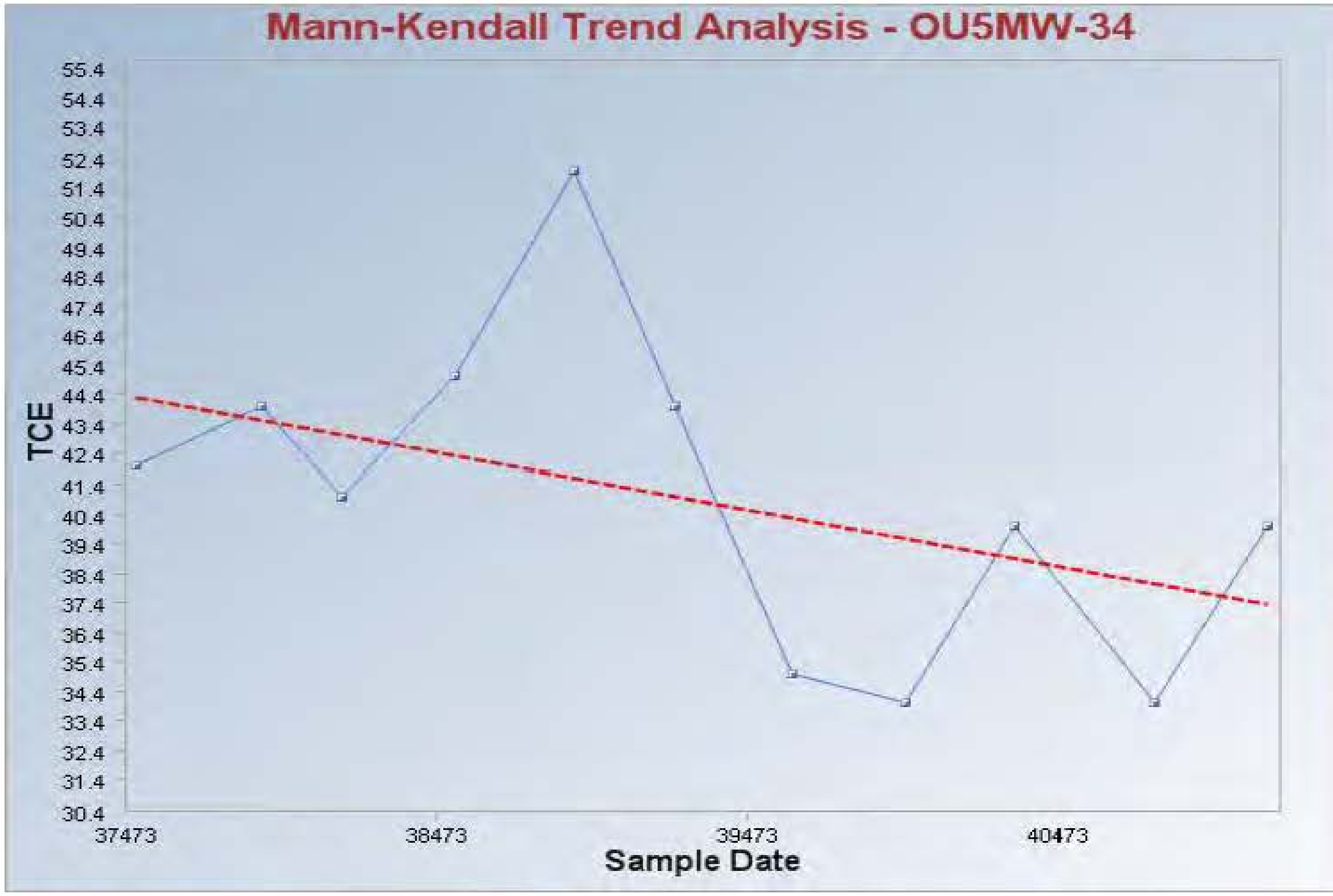
User Selected Options	
Date/Time of Computation	4/8/2013 15:26
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

TCE

General Statistics	
Number of Events	20
Number of Values	20
Minimum	18
Maximum	67
Mean	40.75
Geometric Mean	38.25
Median	40.5
Standard Deviation	14.17
SEM	3.169

Mann-Kendall Test	
Test Value (S)	-144
Tabulated p-value	0
Standard Deviation of S	30.79
Standardized Value of S	-4.644
Approximate p-value	1.71E-06

Statistically significant evidence of a decreasing
trend at the specified level of significance.



Mann-Kendall Trend Analysis

n	11.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-22
Tabulated p-value	0.0430
Standard Deviation of S	12.7279
Standardized Value of S	-1.6499
Approximate p-value	0.0495

Theil-Sen Trend Line = Red

Theil-Sen Slope	-0.0019
Theil-Sen Intercept	116.1686

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - OU5MW-34 (TCE)

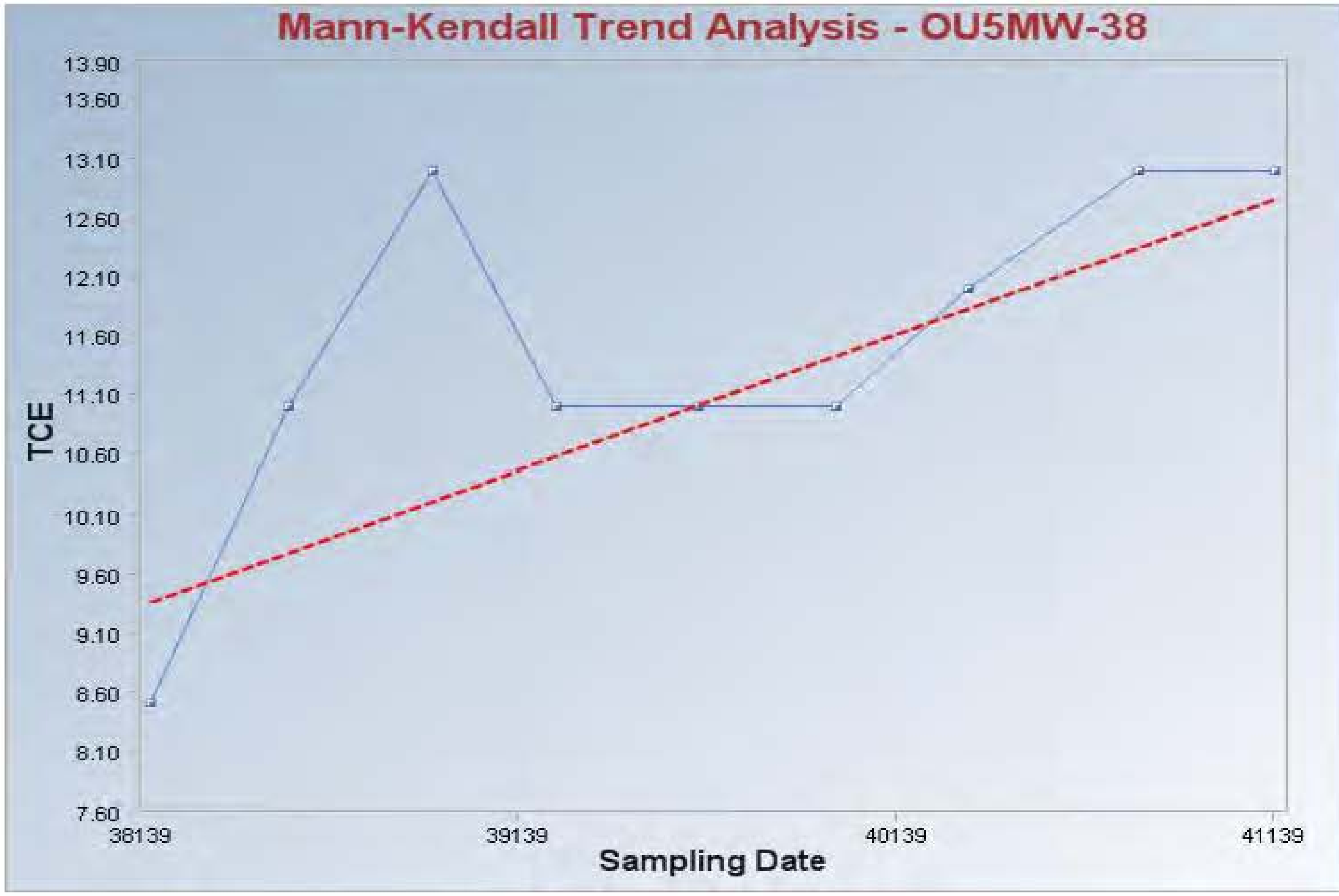
User Selected Options	
Date/Time of Computation	4/8/2013 15:34
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

TCE

General Statistics	
Number of Events	11
Number of Values	11
Minimum	34
Maximum	52
Mean	41
Geometric Mean	40.68
Median	41
Standard Deviation	5.404
SEM	1.629

Mann-Kendall Test	
Test Value (S)	-22
Tabulated p-value	0.043
Standard Deviation of S	12.73
Standardized Value of S	-1.65
Approximate p-value	0.0495

Statistically significant evidence of a decreasing
trend at the specified level of significance.



Mann-Kendall Trend Analysis

n	9.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	19
Tabulated p-value	0.0380
Standard Deviation of S	8.9256
Standardized Value of S	2.0167
Approximate p-value	0.0219

Theil-Sen Trend Line = Red

Theil-Sen Slope	0.0011
Theil-Sen Intercept	-34.3120

Statistically significant evidence of an increasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - OU5MW-38 (TCE)

User Selected Options	
Date/Time of Computation	4/8/2013 15:45
From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

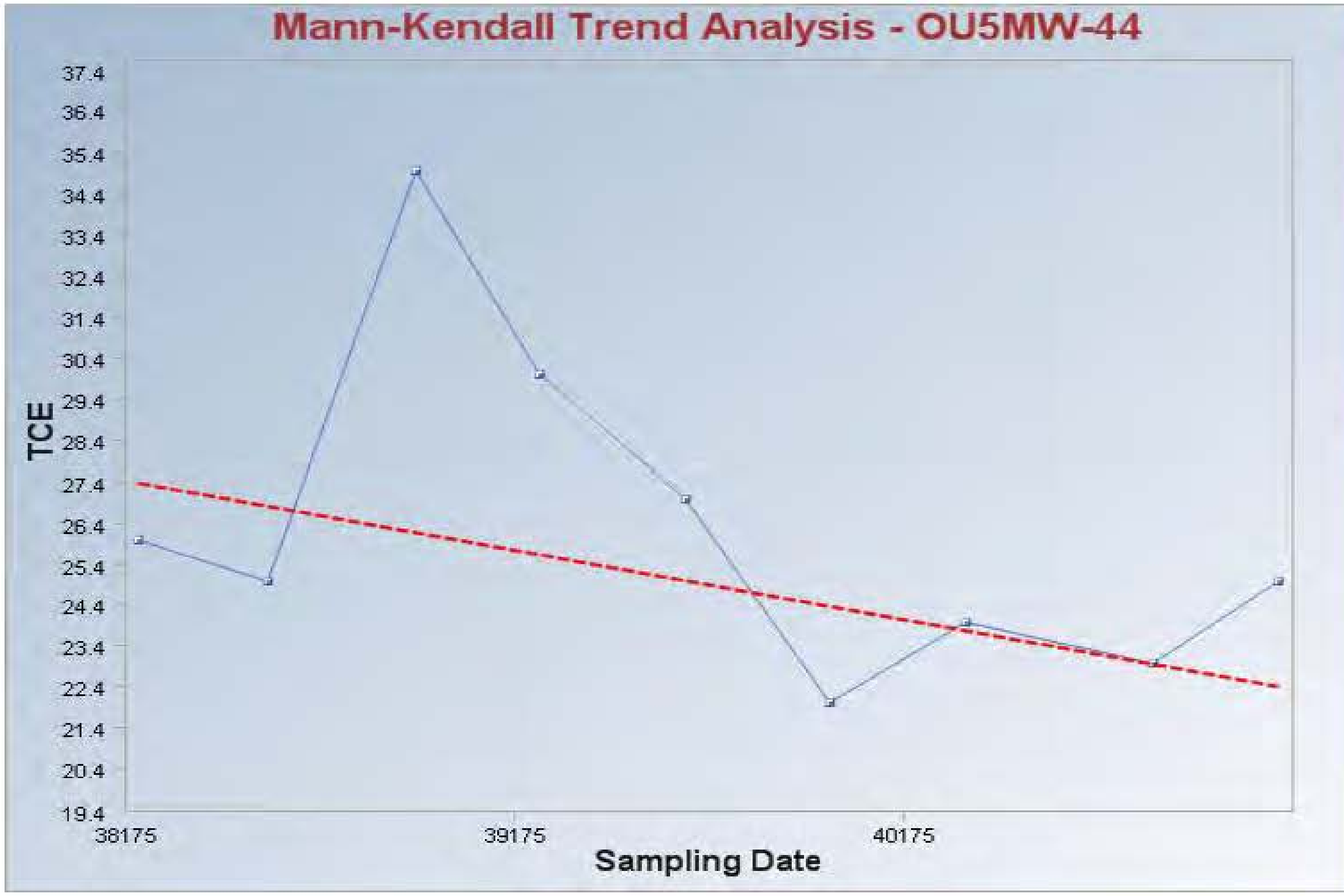
TCE

General Statistics	
Number of Events	9
Number of Values	9
Minimum	8.5
Maximum	13
Mean	11.5
Geometric Mean	11.41
Median	11
Standard Deviation	1.458
SEM	0.486

Mann-Kendall Test	
Test Value (S)	19
Tabulated p-value	0.038
Standard Deviation of S	8.926
Standardized Value of S	2.017
Approximate p-value	0.0219

Statistically significant evidence of an increasing
trend at the specified level of significance.

OU5 (OU5MW-02 Plume)



Mann-Kendall Trend Analysis

n	9.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-13
Tabulated p-value	0.1300
Standard Deviation of S	9.5394
Standardized Value of S	-1.2579
Approximate p-value	0.1042

Theil-Sen Trend Line = Red

Theil-Sen Slope	-0.0017
Theil-Sen Intercept	92.0181

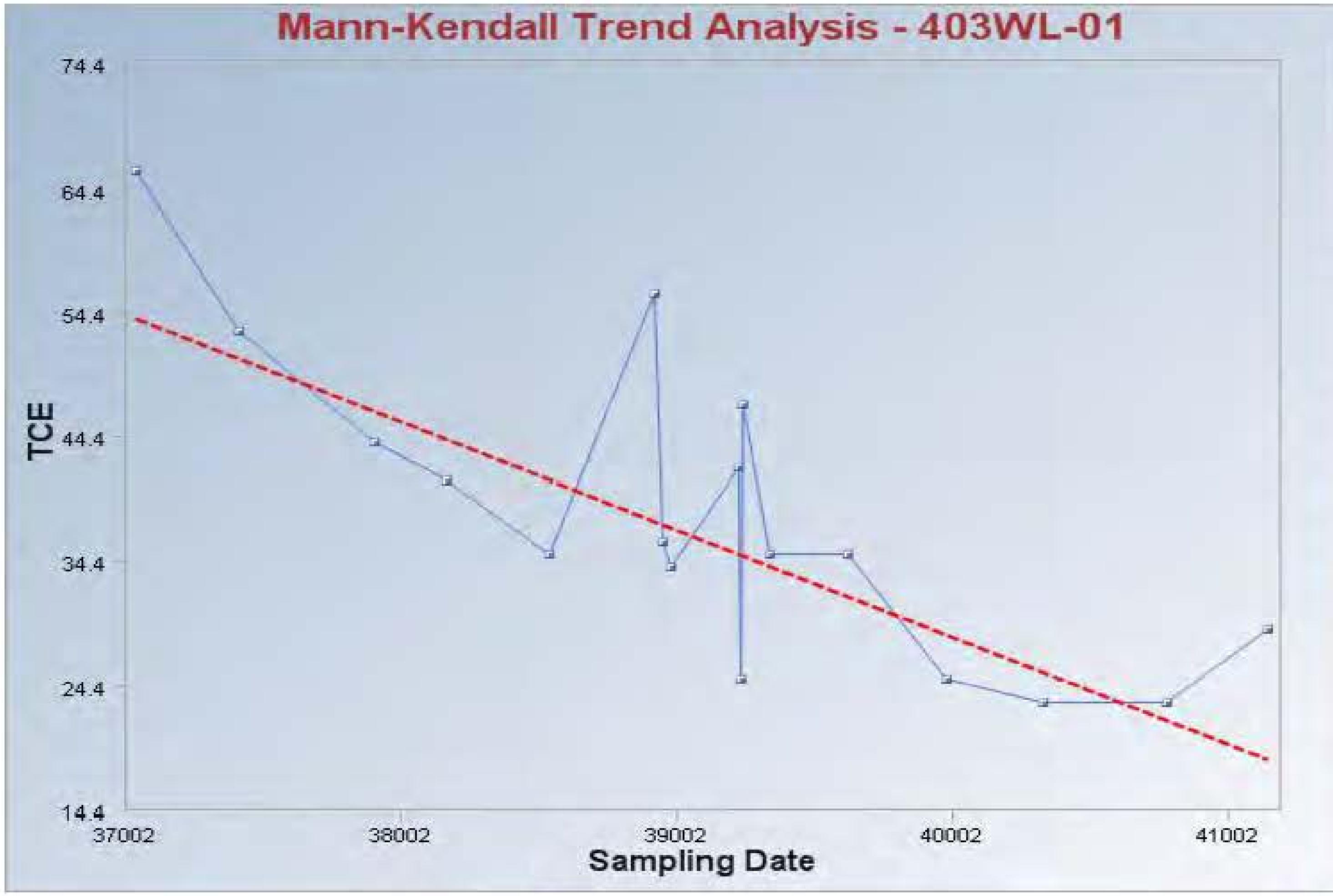
Insufficient statistical evidence of a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - OU5MW-44 (TCE)

User Selected Options		
Date/Time of Computation	4/9/2013 9:40	
Full Precision	OFF	
Confidence Coefficient	0.95	
Level of Significance	0.05	
TCE		
General Statistics		
Number of Events		9
Number of Values		9
Minimum		22
Maximum		35
Mean		26.33
Geometric Mean		26.09
Median		25
Standard Deviation		4
SEM		1.333
Mann-Kendall Test		
Test Value (S)		-13
Tabulated p-value		0.13
Standard Deviation of S		9.539
Standardized Value of S		-1.258
Approximate p-value		0.104

Insufficient evidence to identify a significant
trend at the specified level of significance.

OU5 (Kenney Avenue Plume)



Mann-Kendall Trend Analysis

n	17.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-83
Tabulated p-value	0.0000
Standard Deviation of S	24.1592
Standardized Value of S	-3.3942
Approximate p-value	0.0003

Theil-Sen Trend Line = Red

Theil-Sen Slope	-0.0087
Theil-Sen Intercept	374.5294

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - 403WL-01 (TCE)

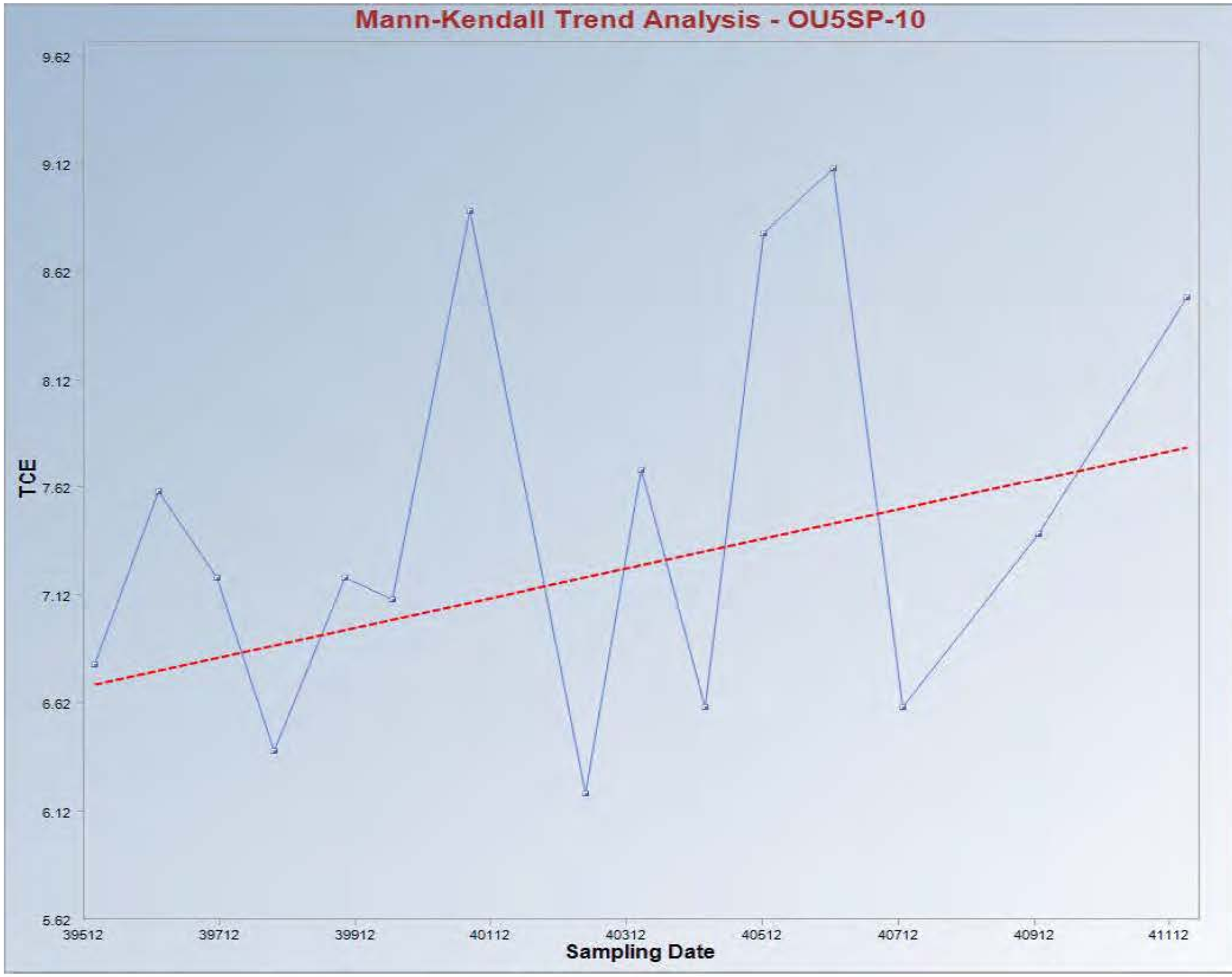
User Selected Options	
Date/Time of Computation	4/8/2013 15:54
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

TCE

General Statistics	
Number of Events	17
Number of Values	17
Minimum	23
Maximum	66
Mean	38.18
Geometric Mean	36.43
Median	35
Standard Deviation	12.22
SEM	2.965

Mann-Kendall Test	
Test Value (S)	-83
Tabulated p-value	0
Standard Deviation of S	24.16
Standardized Value of S	-3.394
Approximate p-value	0.000344

Statistically significant evidence of a decreasing
trend at the specified level of significance.



Mann-Kendall Trend Analysis

n	15.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	21
Tabulated p-value	0.1640
Standard Deviation of S	20.1577
Standardized Value of S	0.9922
Approximate p-value	0.1606

Theil-Sen Trend Line = Red

Theil-Sen Slope	0.0007
Theil-Sen Intercept	-20.3699

Insufficient statistical evidence of a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - OU5SP-10 (TCE)

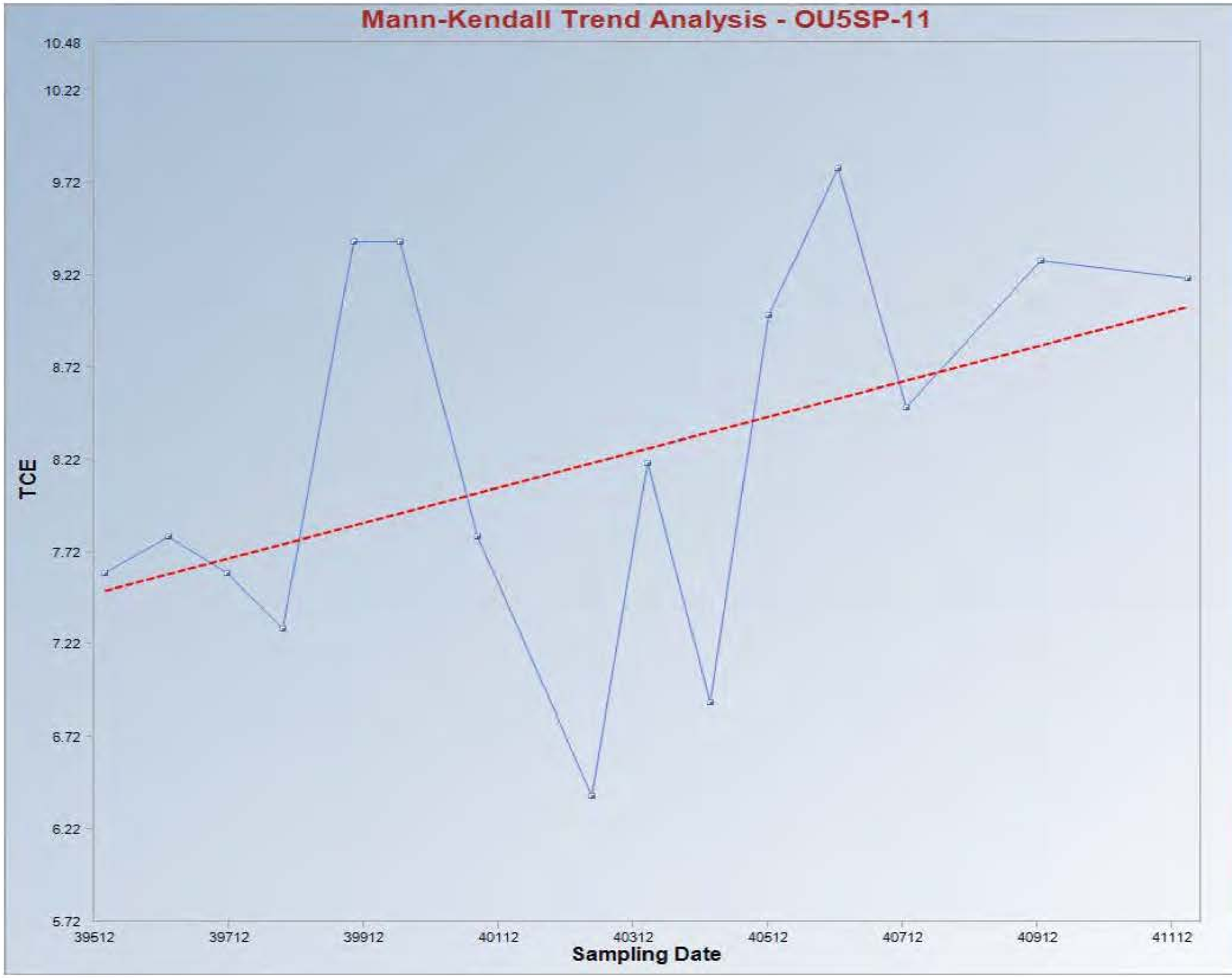
User Selected Options	
Date/Time of Computation	1/30/2014 10:16
From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

TCE

General Statistics	
Number of Events	15
Number of Values	15
Minimum	6.2
Maximum	9.1
Mean	7.473
Geometric Mean	7.419
Median	7.2
Standard Deviation	0.949
SEM	0.245

Mann-Kendall Test	
Test Value (S)	21
Tabulated p-value	0.164
Standard Deviation of S	20.16
Standardized Value of S	0.992
Approximate p-value	0.161

Insufficient evidence to identify a significant
trend at the specified level of significance.



Mann-Kendall Trend Analysis

n	15.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	30
Tabulated p-value	0.0700
Standard Deviation of S	20.1329
Standardized Value of S	1.4404
Approximate p-value	0.0749

Theil-Sen Trend Line = Red

Theil-Sen Slope	0.0010
Theil-Sen Intercept	-30.4419

Insufficient statistical evidence of a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - OU5SP-11 (TCE)

User Selected Options	
Date/Time of Computation	1/30/2014 10:24
From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

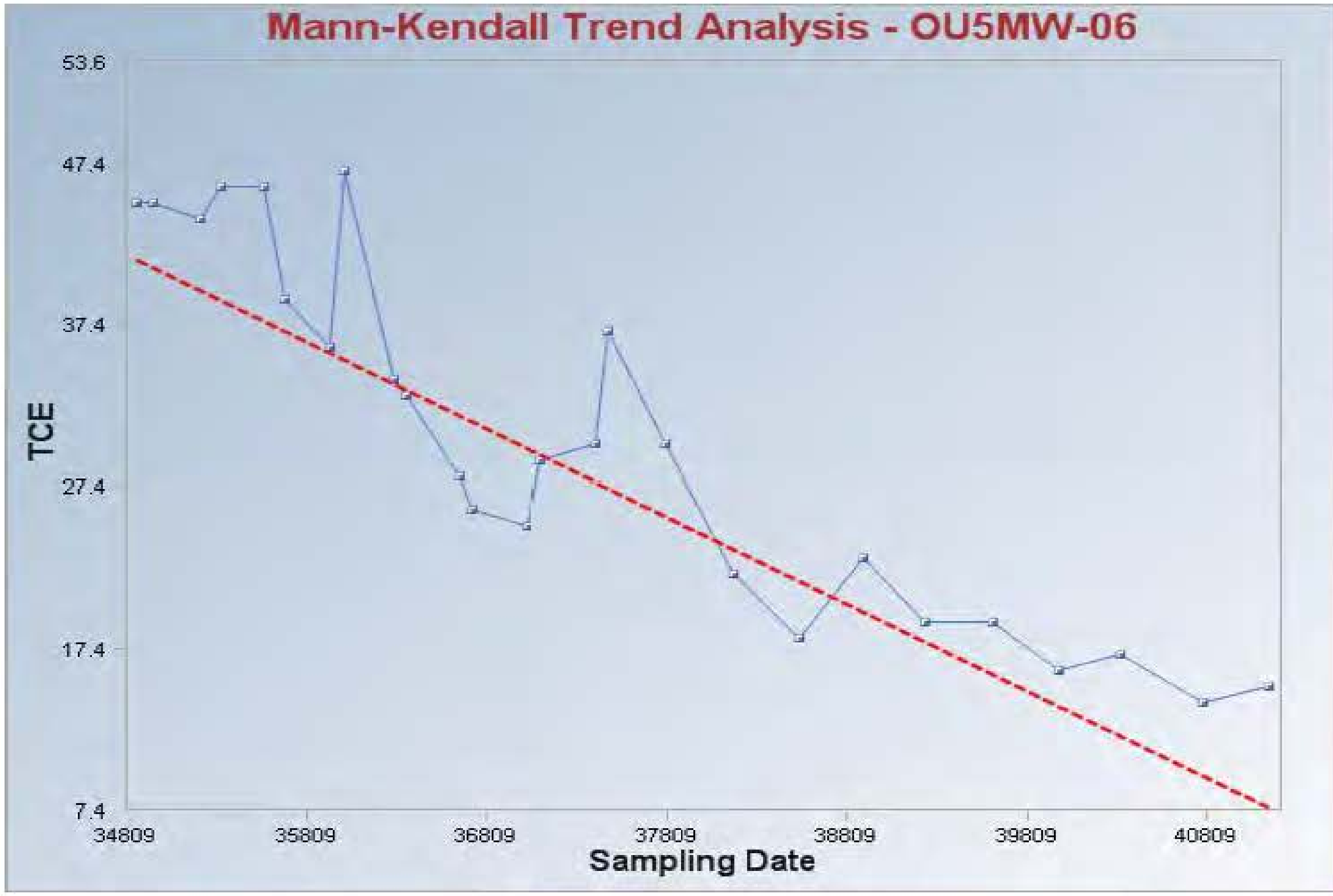
TCE

General Statistics	
Number of Events	15
Number of Values	15
Minimum	6.4
Maximum	9.8
Mean	8.28
Geometric Mean	8.218
Median	8.2
Standard Deviation	1.037
SEM	0.268

Mann-Kendall Test	
Test Value (S)	30
Tabulated p-value	0.07
Standard Deviation of S	20.13
Standardized Value of S	1.44
Approximate p-value	0.0749

Insufficient evidence to identify a significant
trend at the specified level of significance.

OU5 (Slammer Avenue Plume)



Mann-Kendall Trend Analysis

n	26.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-245
Critical Value (0.05)	-1.6449
Standard Deviation of S	45.3248
Standardized Value of S	-5.3834
Approximate p-value	0.0000

Theil-Sen Trend Line = Red

Theil-Sen Slope	-0.0054
Theil-Sen Intercept	229.4209

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - OU5MW-06 (TCE)

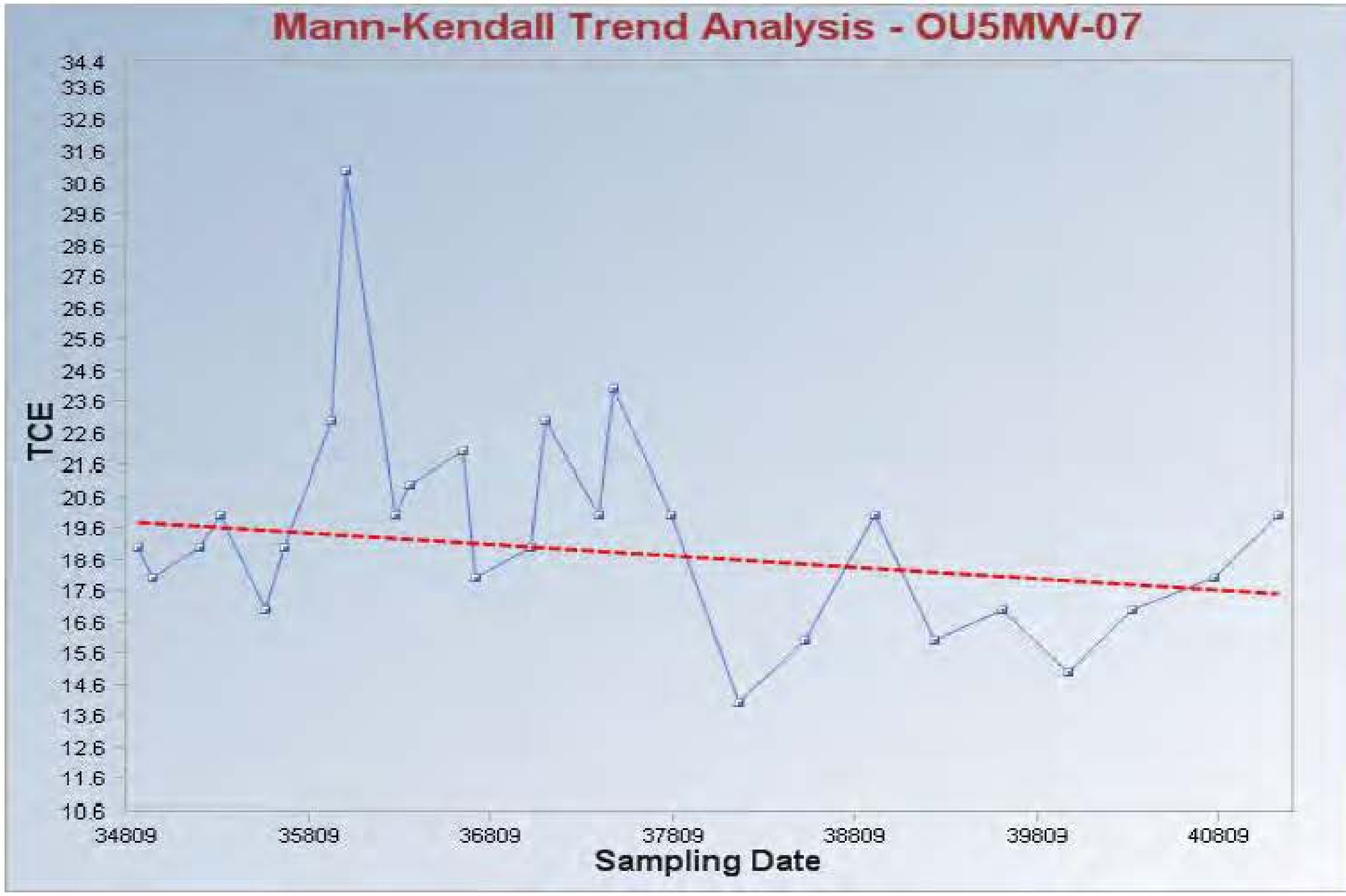
User Selected Options	
Date/Time of Computation	4/8/2013 16:03
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

TCE

General Statistics	
Number of Events	26
Number of Values	26
Minimum	14
Maximum	47
Mean	30.12
Geometric Mean	28.09
Median	29.5
Standard Deviation	11.01
SEM	2.159

Mann-Kendall Test	
Test Value (S)	-245
Critical Value (0.05)	-1.645
Standard Deviation of S	45.32
Standardized Value of S	-5.383
Approximate p-value	3.66E-08

Statistically significant evidence of a decreasing trend at the specified level of significance.



Mann-Kendall Trend Analysis

n	26.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-52
Critical Value (0.05)	-1.6449
Standard Deviation of S	44.8553
Standardized Value of S	-1.1370
Approximate p-value	0.1278

Theil-Sen Trend Line = Red

Theil-Sen Slope	-0.0004
Theil-Sen Intercept	32.5820

Insufficient statistical evidence of a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - OU5MW-07 (TCE)

User Selected Options		
Date/Time of Computation	4/8/2013 16:26	
Full Precision	OFF	
Confidence Coefficient	0.95	
Level of Significance	0.05	

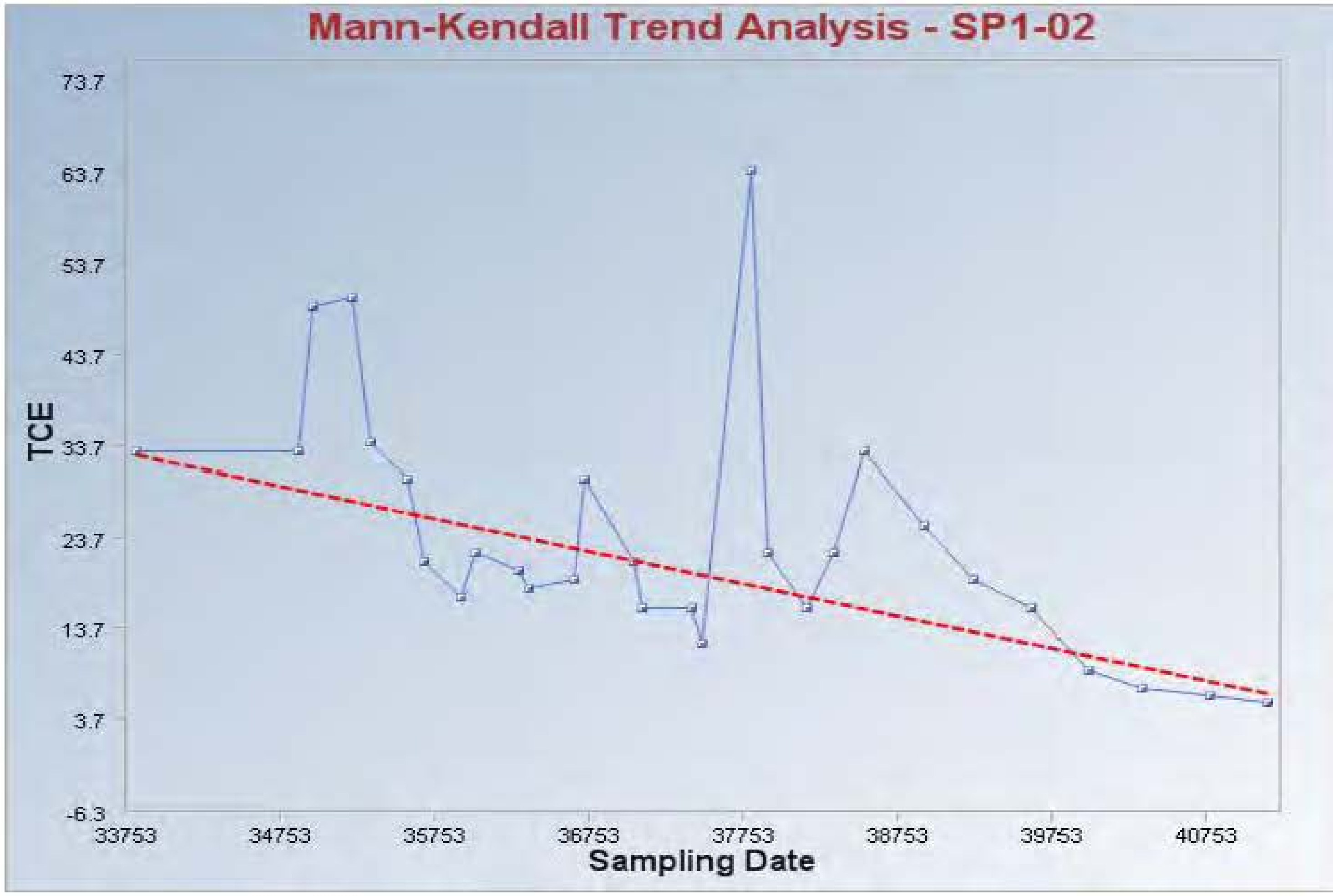
TCE

General Statistics	
Number of Events	26
Number of Values	26
Minimum	14
Maximum	31
Mean	19.46
Geometric Mean	19.2
Median	19
Standard Deviation	3.397
SEM	0.666

Mann-Kendall Test	
Test Value (S)	-52
Critical Value (0.05)	-1.645
Standard Deviation of S	44.86
Standardized Value of S	-1.137
Approximate p-value	0.128

Insufficient evidence to identify a significant
trend at the specified level of significance.

OU5 (SP1-02 Plume)



Mann-Kendall Trend Analysis

n	29.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-201
Critical Value (0.05)	-1.6449
Standard Deviation of S	53.1319
Standardized Value of S	-3.7642
Approximate p-value	0.0001

Theil-Sen Trend Line = Red

Theil-Sen Slope	-0.0036
Theil-Sen Intercept	153.6817

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - SP1-02 (TCE)

User Selected Options		
Date/Time of Computation	4/9/2013 9:52	
From File	WorkSheet.wst	
Full Precision	OFF	
Confidence Coefficient	0.95	
Level of Significance	0.05	

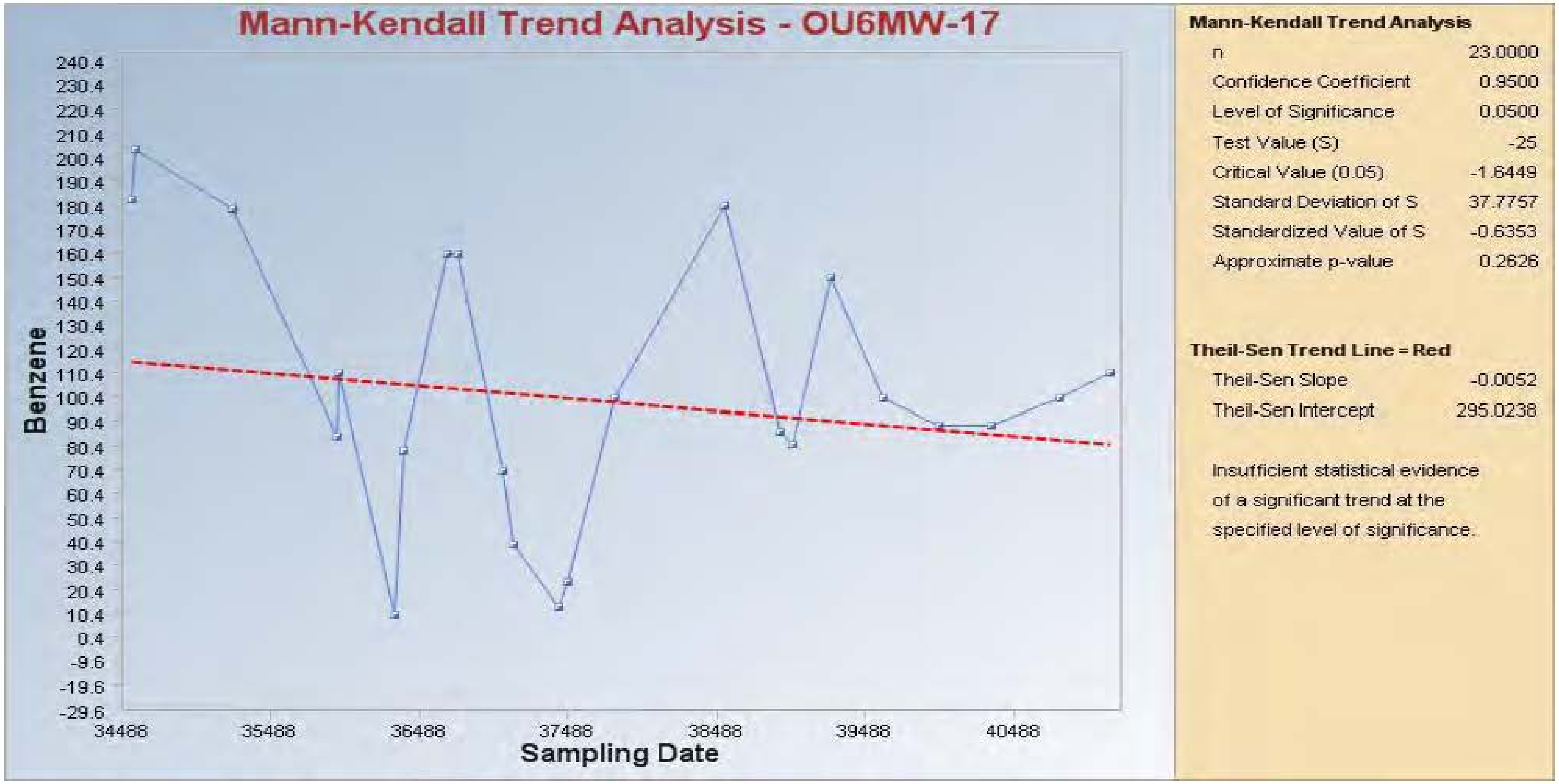
TCE

General Statistics	
Number of Events	29
Number of Values	29
Minimum	5.4
Maximum	64
Mean	23.64
Geometric Mean	20.23
Median	21
Standard Deviation	13.45
SEM	2.498

Mann-Kendall Test	
Test Value (S)	-201
Critical Value (0.05)	-1.645
Standard Deviation of S	53.13
Standardized Value of S	-3.764
Approximate p-value	8.35E-05

Statistically significant evidence of a decreasing
trend at the specified level of significance.

OU6 (SD015)


Mann-Kendall Trend Analysis - OU6MW-17
Benzene
Sampling Date
240.4
230.4
220.4
210.4
200.4
190.4
180.4
170.4
160.4
150.4
140.4
130.4
120.4
110.4
100.4
90.4
80.4
70.4
60.4
50.4
40.4
30.4
20.4
10.4
0.4
-9.6
-19.6
-29.6
34488
35488
36488
37488
38488
39488
40488
Mann-Kendall Trend Analysis
n 23.0000
Confidence Coefficient 0.9500
Level of Significance 0.0500
Test Value (S) -25
Critical Value (0.05) -1.6449
Standard Deviation of S 37.7757
Standardized Value of S -0.6353
Approximate p-value 0.2626
Theil-Sen Trend Line = Red
Theil-Sen Slope -0.0052
Theil-Sen Intercept 295.0238
Insufficient statistical evidence
of a significant trend at the
specified level of significance.

Mann-Kendall Trend Test Analysis - OU6MW-17 (Benzene)

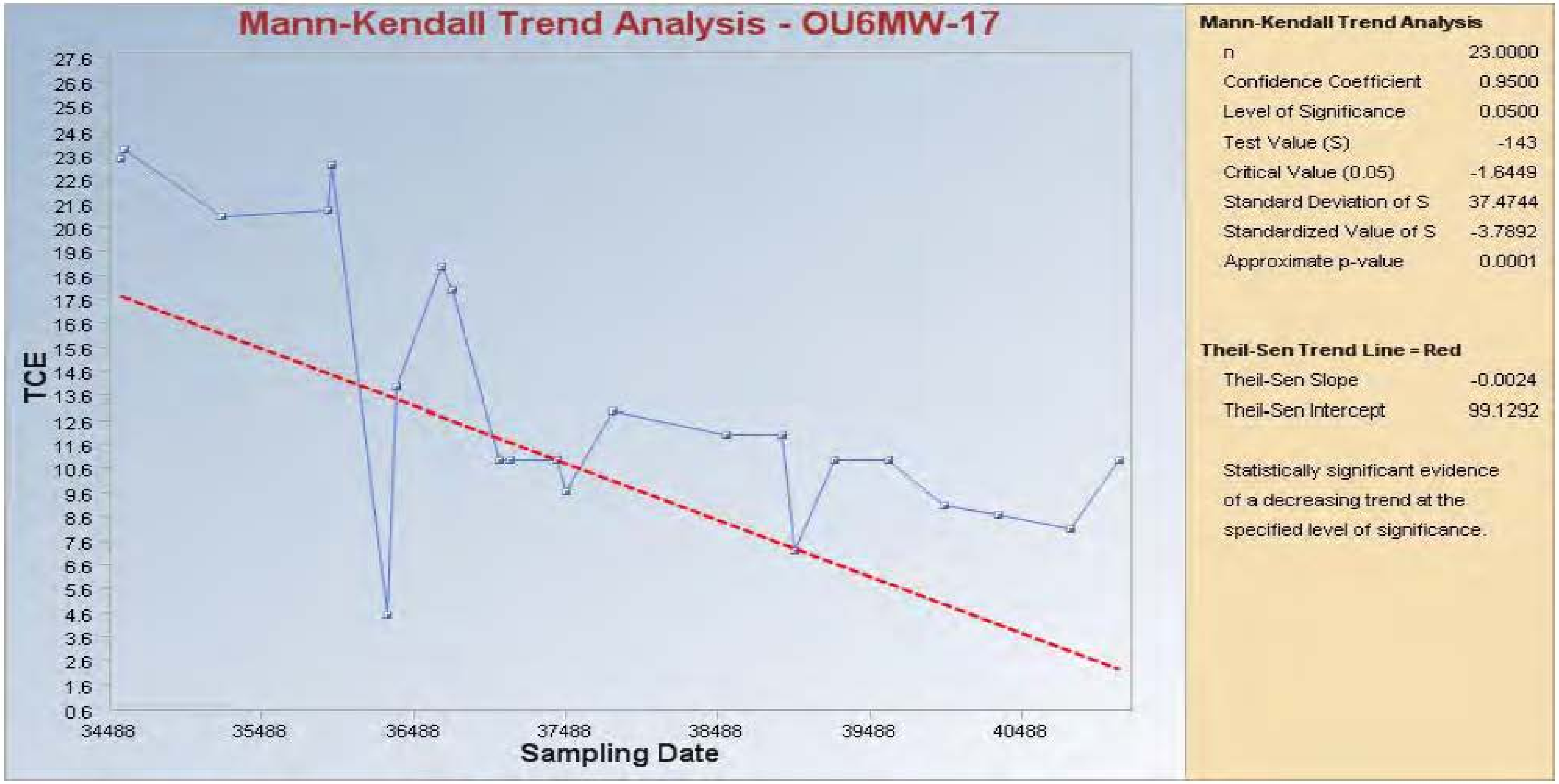
User Selected Options	
Date/Time of Computation	4/11/2013 12:59
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

Benzene

General Statistics	
Number of Events	23
Number of Values	23
Minimum	9.3
Maximum	204
Mean	104.2
Geometric Mean	83.4
Median	100
Standard Deviation	55.48
SEM	11.57

Mann-Kendall Test	
Test Value (S)	-25
Critical Value (0.05)	-1.645
Standard Deviation of S	37.78
Standardized Value of S	-0.635
Approximate p-value	0.263

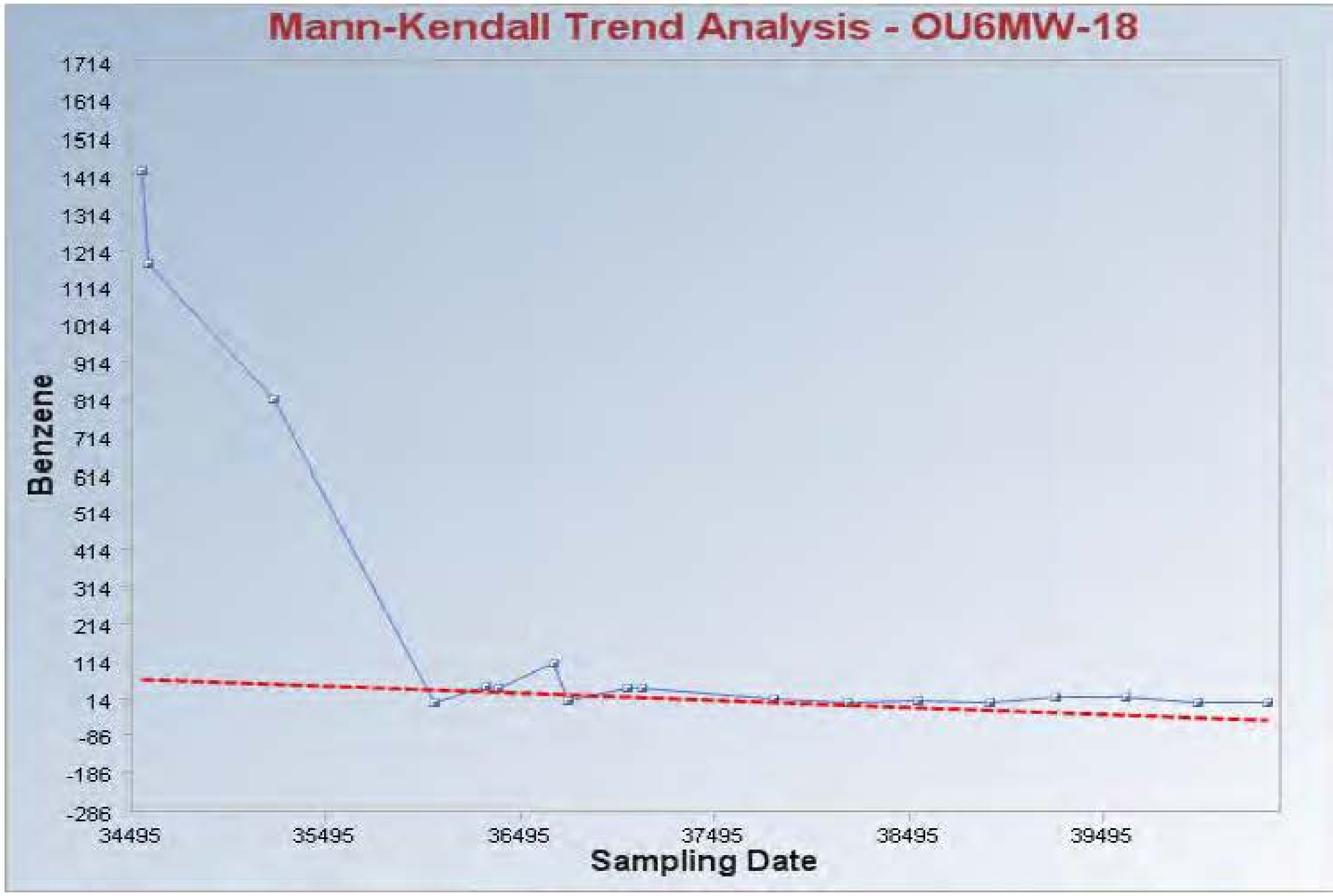
Insufficient evidence to identify a significant trend at the specified level of significance.


Mann-Kendall Trend Analysis - OU6MW-17
TCE
Sampling Date
27.6
26.6
25.6
24.6
23.6
22.6
21.6
20.6
19.6
18.6
17.6
16.6
15.6
14.6
13.6
12.6
11.6
10.6
9.6
8.6
7.6
6.6
5.6
4.6
3.6
2.6
1.6
0.6
34488
35488
36488
37488
38488
39488
40488
Mann-Kendall Trend Analysis
n 23.0000
Confidence Coefficient 0.9500
Level of Significance 0.0500
Test Value (S) -143
Critical Value (0.05) -1.6449
Standard Deviation of S 37.4744
Standardized Value of S -3.7892
Approximate p-value 0.0001
Theil-Sen Trend Line = Red
Theil-Sen Slope -0.0024
Theil-Sen Intercept 99.1292
Statistically significant evidence
of a decreasing trend at the
specified level of significance.

Mann-Kendall Trend Test Analysis - OU6MW-17 (TCE)

User Selected Options		
Date/Time of Computation	4/11/2013 16:05	
Full Precision	OFF	
Confidence Coefficient	0.95	
Level of Significance	0.05	
TCE		
General Statistics		
Number of Events		23
Number of Values		23
Minimum		4.5
Maximum		23.9
Mean		13.67
Geometric Mean		12.56
Median		11
Standard Deviation		5.72
SEM		1.193
Mann-Kendall Test		
Test Value (S)		-143
Critical Value (0.05)		-1.645
Standard Deviation of S		37.47
Standardized Value of S		-3.789
Approximate p-value		7.56E-05

Statistically significant evidence of a decreasing
trend at the specified level of significance.



Mann-Kendall Trend Analysis

n	18.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-82
Tabulated p-value	0.0010
Standard Deviation of S	26.3818
Standardized Value of S	-3.0703
Approximate p-value	0.0011

Theil-Sen Trend Line = Red

Theil-Sen Slope	-0.0197
Theil-Sen Intercept	747.0332

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - OU6MW-18 (Benzene)

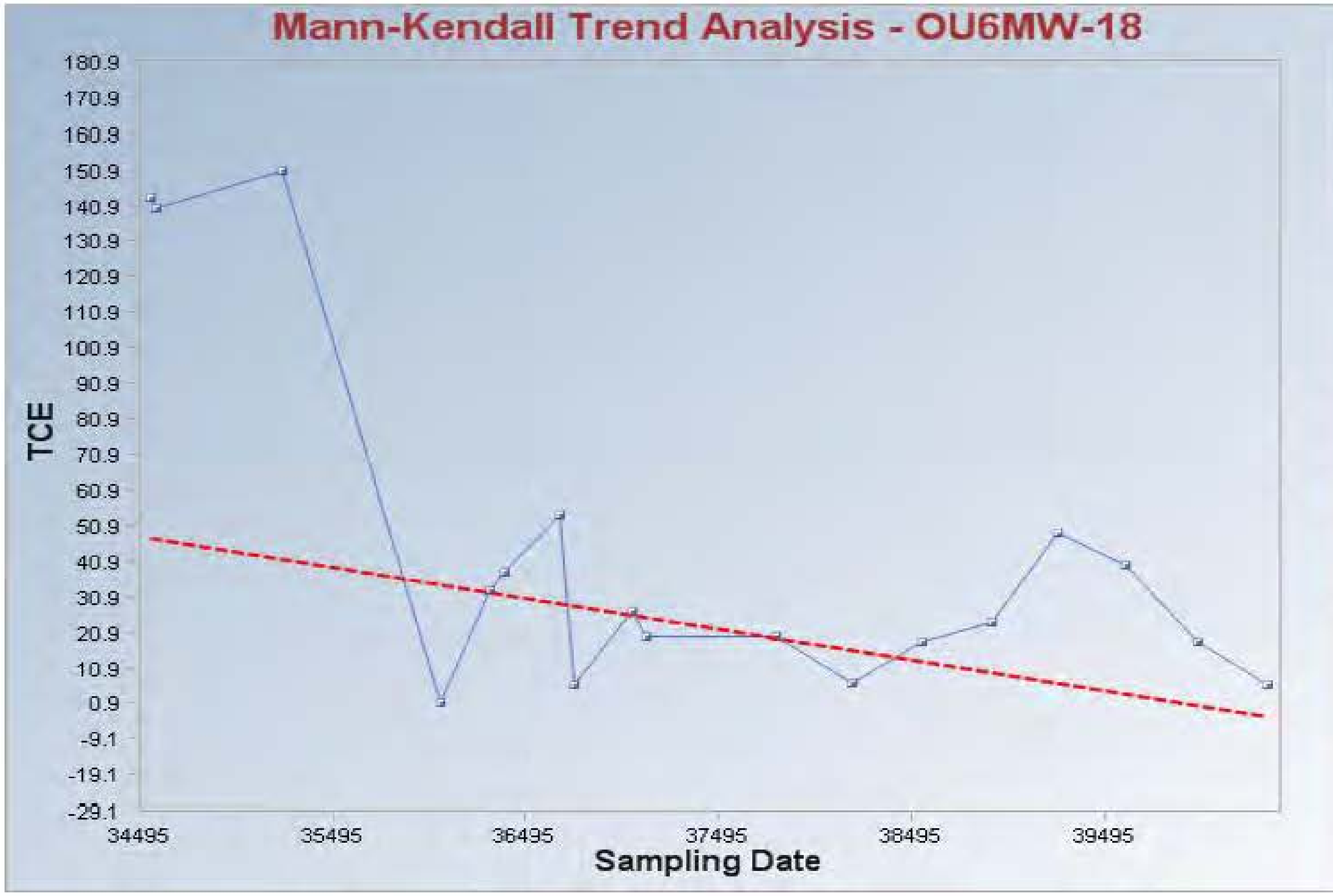
User Selected Options	
Date/Time of Computation	4/11/2013 16:26
From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

Benzene

General Statistics	
Number of Events	18
Number of Values	18
Minimum	0.12
Maximum	1430
Mean	209.1
Geometric Mean	17.61
Median	16.5
Standard Deviation	442.7
SEM	104.4

Mann-Kendall Test	
Test Value (S)	-82
Tabulated p-value	0.001
Standard Deviation of S	26.38
Standardized Value of S	-3.07
Approximate p-value	0.00107

Statistically significant evidence of a decreasing
trend at the specified level of significance.



Mann-Kendall Trend Analysis	
n	18.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-51
Tabulated p-value	0.0290
Standard Deviation of S	26.3629
Standardized Value of S	-1.8966
Approximate p-value	0.0289

Theil-Sen Trend Line = Red

Theil-Sen Slope	-0.0088
Theil-Sen Intercept	351.0047

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - OU6MW-18 (TCE)

User Selected Options	
Date/Time of Computation	4/11/2013 16:28
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

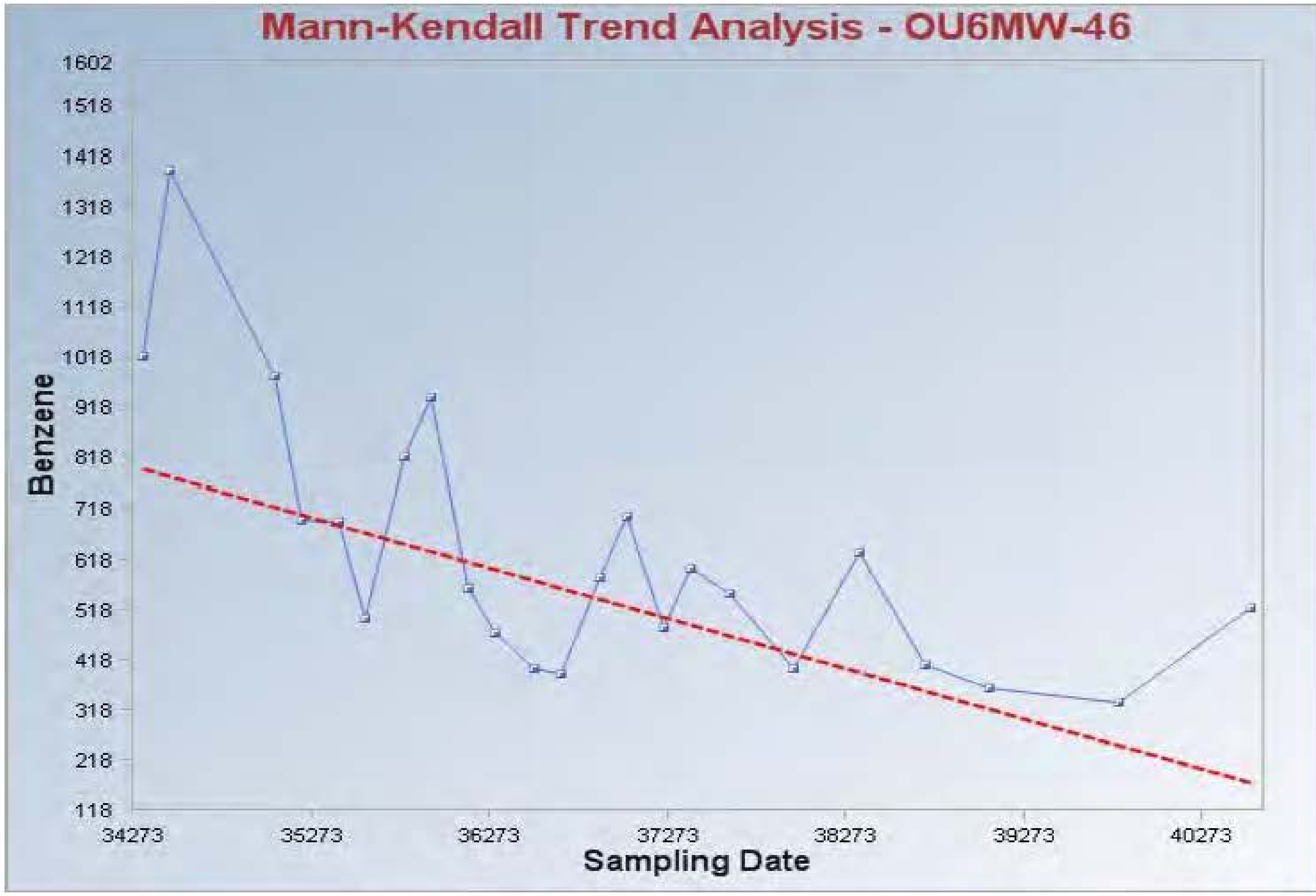
TCE

General Statistics	
Number of Events	18
Number of Values	18
Minimum	0.9
Maximum	151
Mean	44.16
Geometric Mean	24.13
Median	25.5
Standard Deviation	48.55
SEM	11.44

Mann-Kendall Test	
Test Value (S)	-51
Tabulated p-value	0.029
Standard Deviation of S	26.36
Standardized Value of S	-1.897
Approximate p-value	0.0289

Statistically significant evidence of a decreasing
trend at the specified level of significance.

OU6 (WP014)



Mann-Kendall Trend Analysis

n	23.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-132
Critical Value (0.05)	-1.6449
Standard Deviation of S	37.8506
Standardized Value of S	-3.4610
Approximate p-value	0.0003

Theil-Sen Trend Line = Red

Theil-Sen Slope	-0.1004
Theil-Sen Intercept	4,241.1861

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - OU6MW-46 (Benzene)

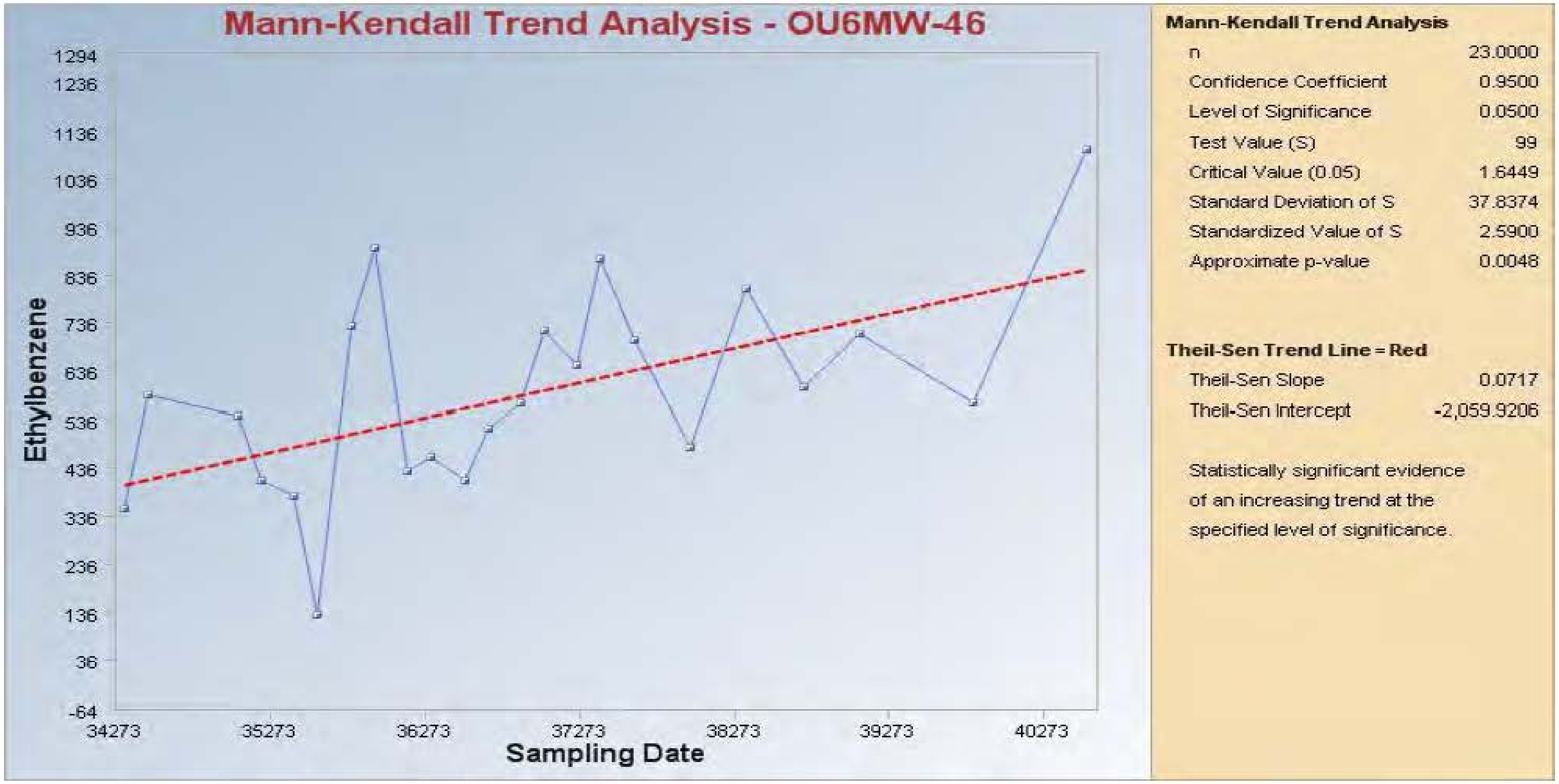
User Selected Options	
Date/Time of Computation	4/9/2013 10:13
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

Benzene

General Statistics	
Number of Events	23
Number of Values	23
Minimum	330
Maximum	1390
Mean	626.3
Geometric Mean	584.1
Median	560
Standard Deviation	257.8
SEM	53.76

Mann-Kendall Test	
Test Value (S)	-132
Critical Value (0.05)	-1.645
Standard Deviation of S	37.85
Standardized Value of S	-3.461
Approximate p-value	

Statistically significant evidence of a decreasing
trend at the specified level of significance.


Mann-Kendall Trend Analysis - OU6MW-46
Ethylbenzene
1294
1236
1136
1036
936
836
736
636
536
436
336
236
136
36
-64
34273
35273
36273
37273
38273
39273
40273
Sampling Date
Mann-Kendall Trend Analysis
n 23.0000
Confidence Coefficient 0.9500
Level of Significance 0.0500
Test Value (S) 99
Critical Value (0.05) 1.6449
Standard Deviation of S 37.8374
Standardized Value of S 2.5900
Approximate p-value 0.0048
Theil-Sen Trend Line = Red
Theil-Sen Slope 0.0717
Theil-Sen Intercept -2,059.9206
Statistically significant evidence of an increasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - OU6MW-46 (Ethylbenzene)

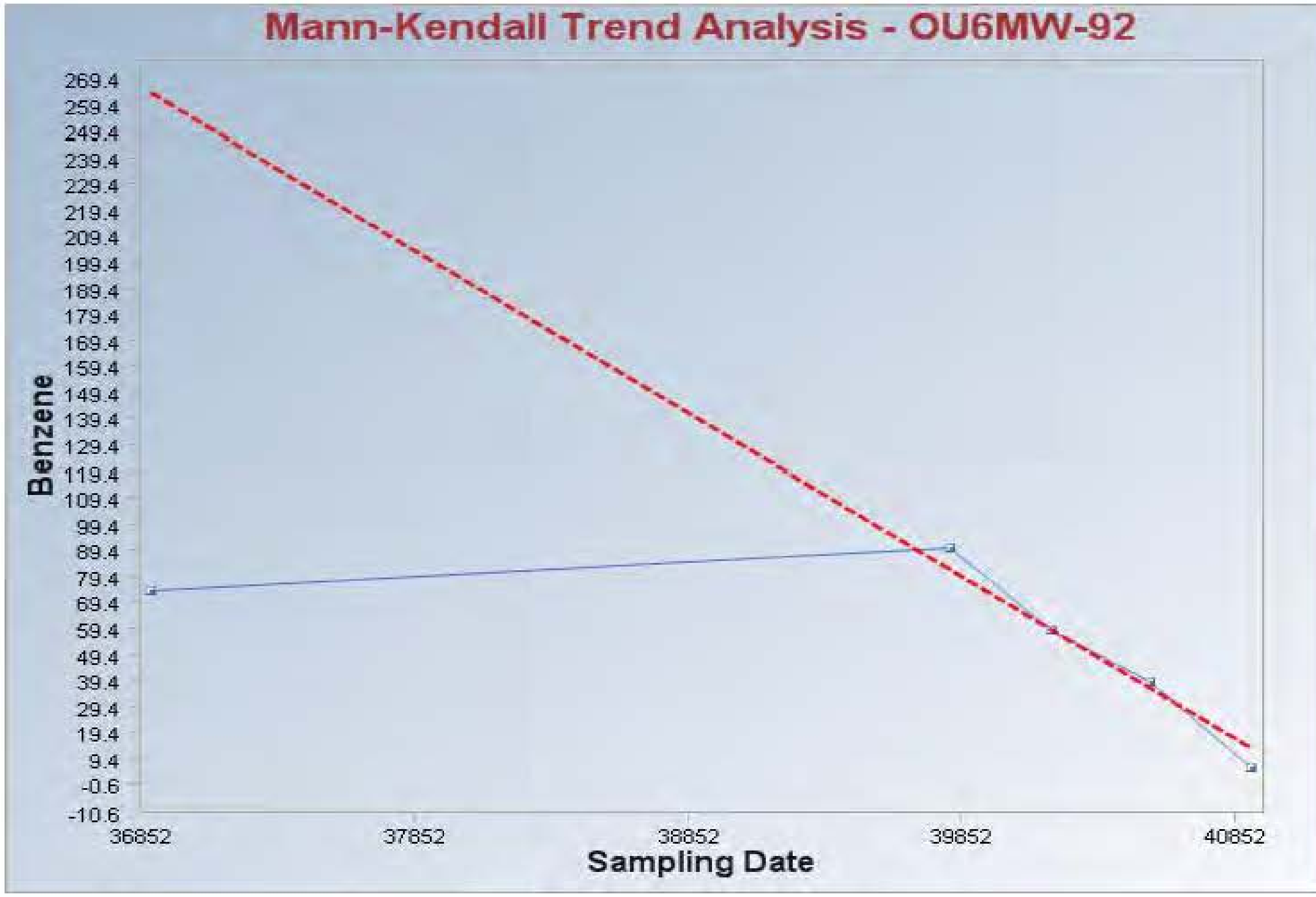
User Selected Options	
Date/Time of Computation	4/9/2013 10:15
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

Ethylbenzene

General Statistics	
Number of Events	23
Number of Values	23
Minimum	130
Maximum	1100
Mean	592.9
Geometric Mean	550.1
Median	570
Standard Deviation	211.8
SEM	44.16

Mann-Kendall Test	
Test Value (S)	99
Critical Value (0.05)	1.645
Standard Deviation of S	37.84
Standardized Value of S	2.59
Approximate p-value	0.0048

Statistically significant evidence of an increasing
trend at the specified level of significance.



Mann-Kendall Trend Analysis

n	5.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-8
Tabulated p-value	0.0420
Standard Deviation of S	4.0825
Standardized Value of S	-1.7146
Approximate p-value	0.0432

Theil-Sen Trend Line = Red

Theil-Sen Slope	-0.0623
Theil-Sen Intercept	2,563.3075

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - OU6MW-92 (Benzene)

User Selected Options	
Date/Time of Computation	4/9/2013 10:22
From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

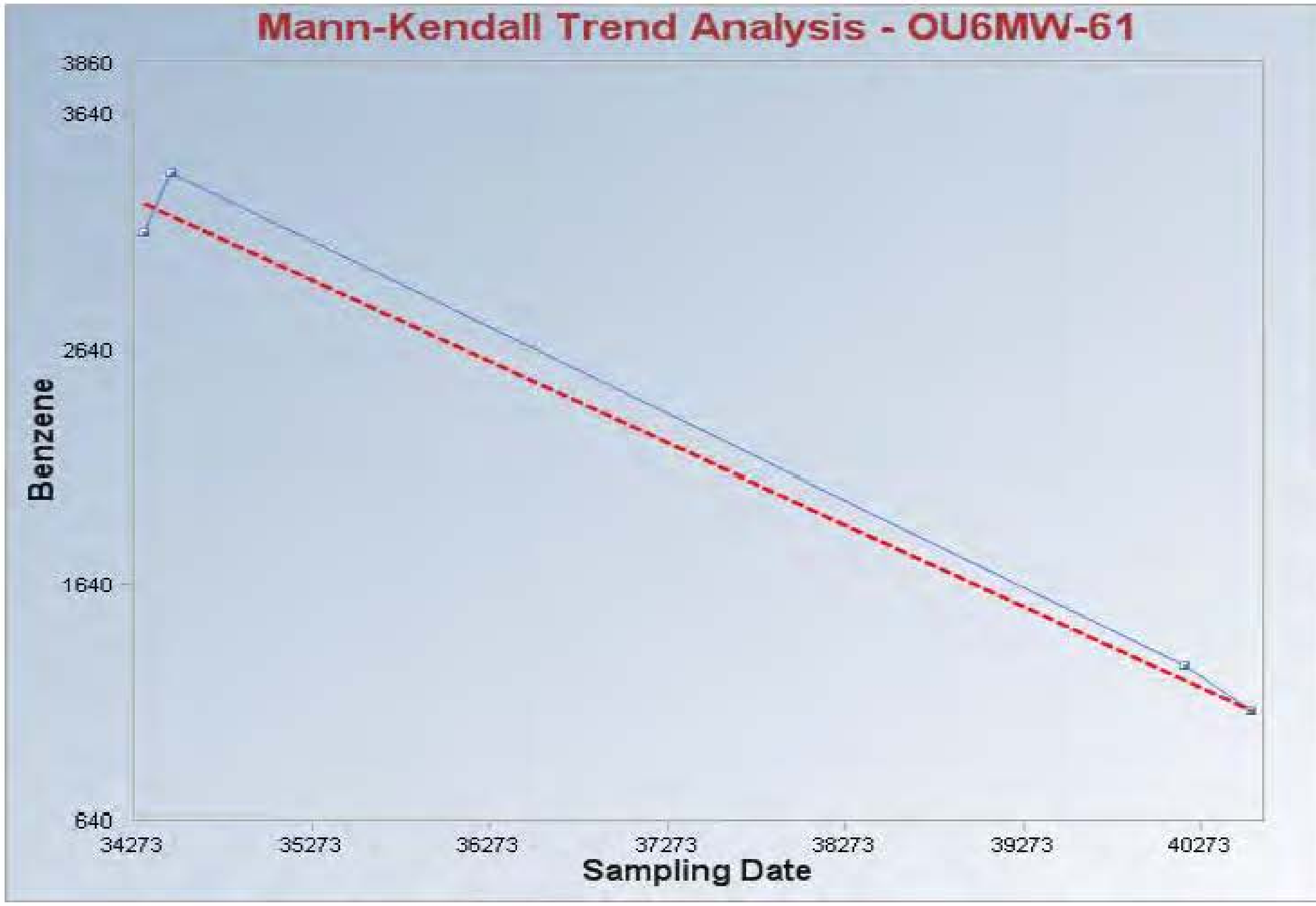
Benzene

General Statistics	
Number of Events	5
Number of Values	5
Minimum	6.2
Maximum	90
Mean	53.64
Geometric Mean	39.41
Median	59
Standard Deviation	32.52
SEM	14.54

Mann-Kendall Test	
Test Value (S)	-8
Tabulated p-value	0.042
Standard Deviation of S	4.082
Standardized Value of S	-1.715
Approximate p-value	0.0432

Statistically significant evidence of a decreasing
trend at the specified level of significance.

OU6 (LF004)



Mann-Kendall Trend Analysis

n	4.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-4
Tabulated p-value	0.1670
Standard Deviation of S	2.9439
Standardized Value of S	-1.0190
Approximate p-value	0.1541

Theil-Sen Trend Line = Red

Theil-Sen Slope	-0.3487
Theil-Sen Intercept	15,238.3911

Insufficient statistical evidence of a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - OU6MW-61 (Benzene)

User Selected Options	
Date/Time of Computation	4/18/2013 14:01
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

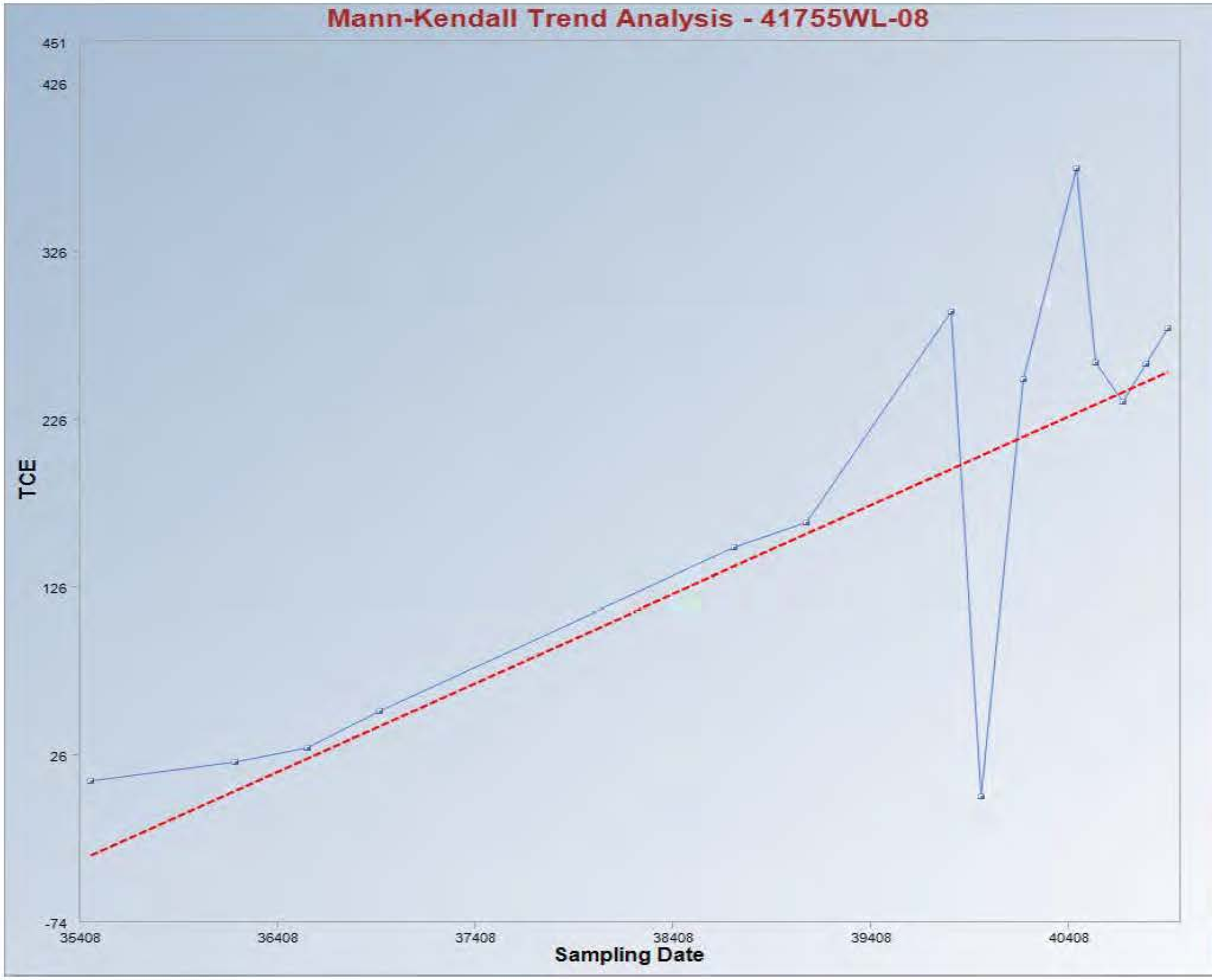
Benzene

General Statistics	
Number of Events	4
Number of Values	4
Minimum	1100
Maximum	3400
Mean	2235
Geometric Mean	1977
Median	2220
Standard Deviation	1203
SEM	601.3

Mann-Kendall Test	
Test Value (S)	-4
Tabulated p-value	0.167
Standard Deviation of S	2.944
Standardized Value of S	-1.019
Approximate p-value	0.154

Insufficient evidence to identify a significant trend at the specified level of significance.

DP098



Mann-Kendall Trend Analysis

n	14.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	53
Tabulated p-value	0.0020
Standard Deviation of S	18.2665
Standardized Value of S	2.8467
Approximate p-value	0.0022

Theil-Sen Trend Line = Red

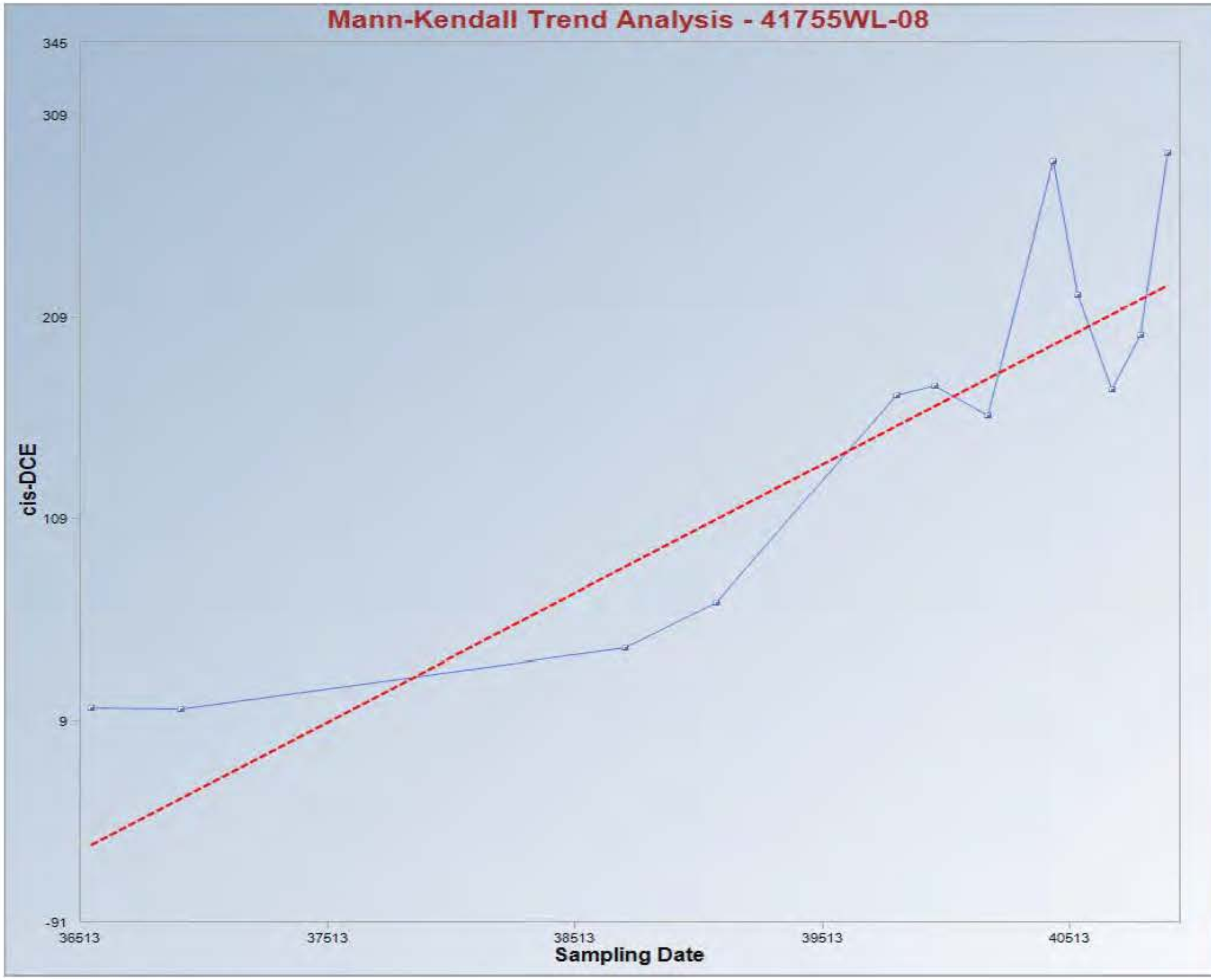
Theil-Sen Slope	0.0530
Theil-Sen Intercept	-1,912.9118

Statistically significant evidence of an increasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - 41755WL-08 (TCE)

User Selected Options	
Date/Time of Computation	3/4/2014 14:26
From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05
Sampling Date	
General Statistics	
Number of Events	14
Number of Values	14
Minimum	1
Maximum	376
Mean	169.9
Geometric Mean	84.95
Median	200
Standard Deviation	125.8
SEM	33.62
Mann-Kendall Test	
Test Value (S)	53
Tabulated p-value	0.002
Standard Deviation of S	18.27
Standardized Value of S	2.847
Approximate p-value	0.00221

Statistically significant evidence of an increasing
trend at the specified level of significance.



Mann-Kendall Trend Analysis

n	12.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	48
Tabulated p-value	0.0000
Standard Deviation of S	14.5831
Standardized Value of S	3.2229
Approximate p-value	0.0006

Theil-Sen Trend Line = Red

Theil-Sen Slope	0.0637
Theil-Sen Intercept	-2,382.3629

Statistically significant evidence of an increasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - 41755WL-08 (cis-DCE)

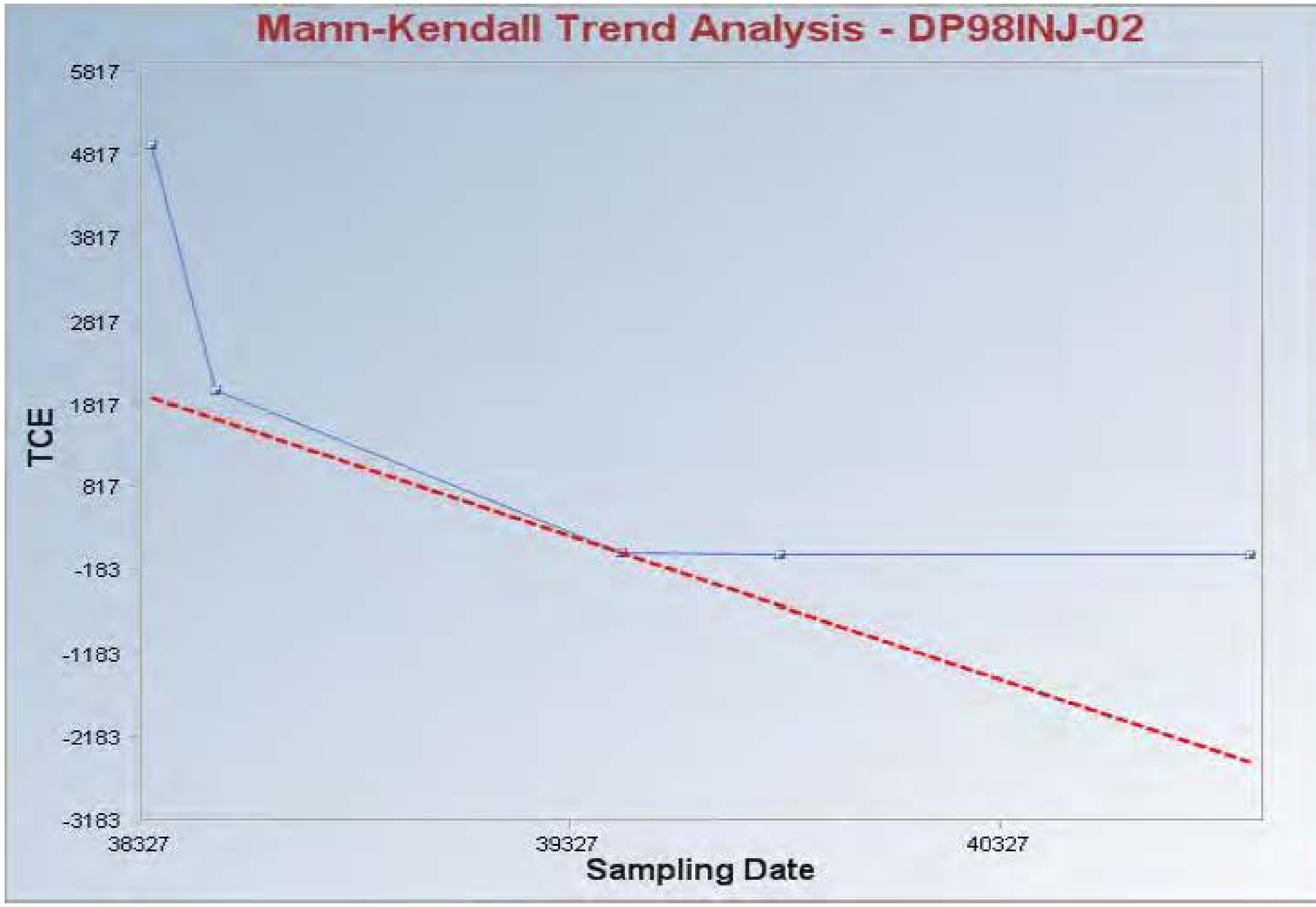
User Selected Options	
Date/Time of Computation	3/4/2014 14:35
From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

cis-DCE

General Statistics	
Number of Events	12
Number of Values	12
Minimum	15
Maximum	290
Mean	151.4
Geometric Mean	106.4
Median	171.5
Standard Deviation	95.99
SEM	27.71

Mann-Kendall Test	
Test Value (S)	48
Tabulated p-value	0
Standard Deviation of S	14.58
Standardized Value of S	3.223
Approximate p-value	6.34E-04

Statistically significant evidence of an increasing
trend at the specified level of significance.



Mann-Kendall Trend Analysis

n	5.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-8
Tabulated p-value	0.0420
Standard Deviation of S	4.0825
Standardized Value of S	-1.7146
Approximate p-value	0.0432

Theil-Sen Trend Line = Red

Theil-Sen Slope	-1.7177
Theil-Sen Intercept	67,773.2633

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - DP98INJ-02 (TCE)

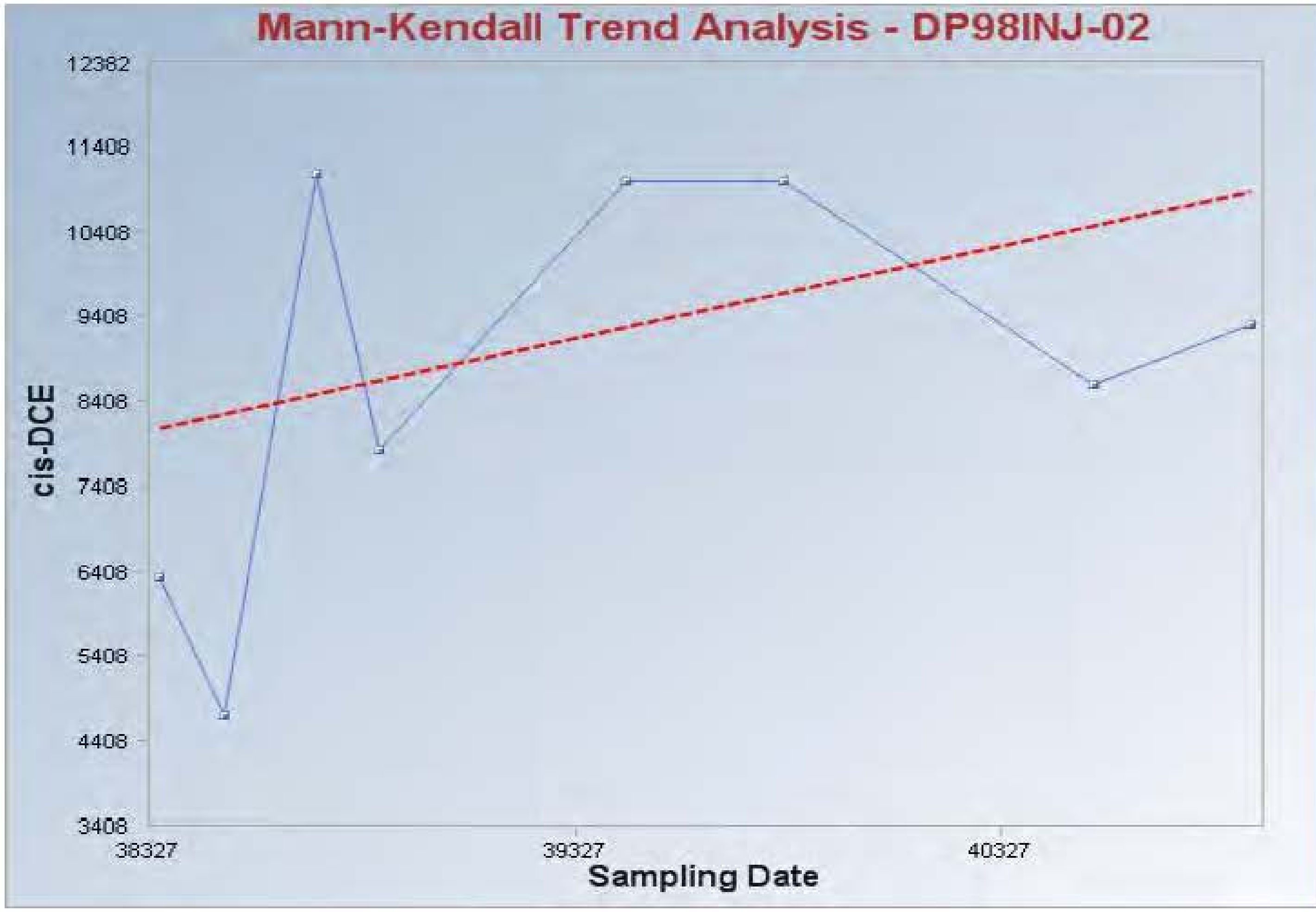
User Selected Options	
Date/Time of Computation	4/9/2013 14:51
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

TCE

General Statistics	
Number of Events	5
Number of Values	5
Minimum	0.66
Maximum	4920
Mean	1383
Geometric Mean	41.65
Median	15
Standard Deviation	2154
SEM	963.3

Mann-Kendall Test	
Test Value (S)	-8
Tabulated p-value	0.042
Standard Deviation of S	4.082
Standardized Value of S	-1.715
Approximate p-value	0.0432

Statistically significant evidence of a decreasing trend at the specified level of significance.



Mann-Kendall Trend Analysis

n	8.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	7
Tabulated p-value	0.2740
Standard Deviation of S	8.0208
Standardized Value of S	0.7481
Approximate p-value	0.2272

Theil-Sen Trend Line = Red

Theil-Sen Slope	1.0948
Theil-Sen Intercept	-33,919.7848

Insufficient statistical evidence of a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - DP98INJ-02 (cis-DCE)

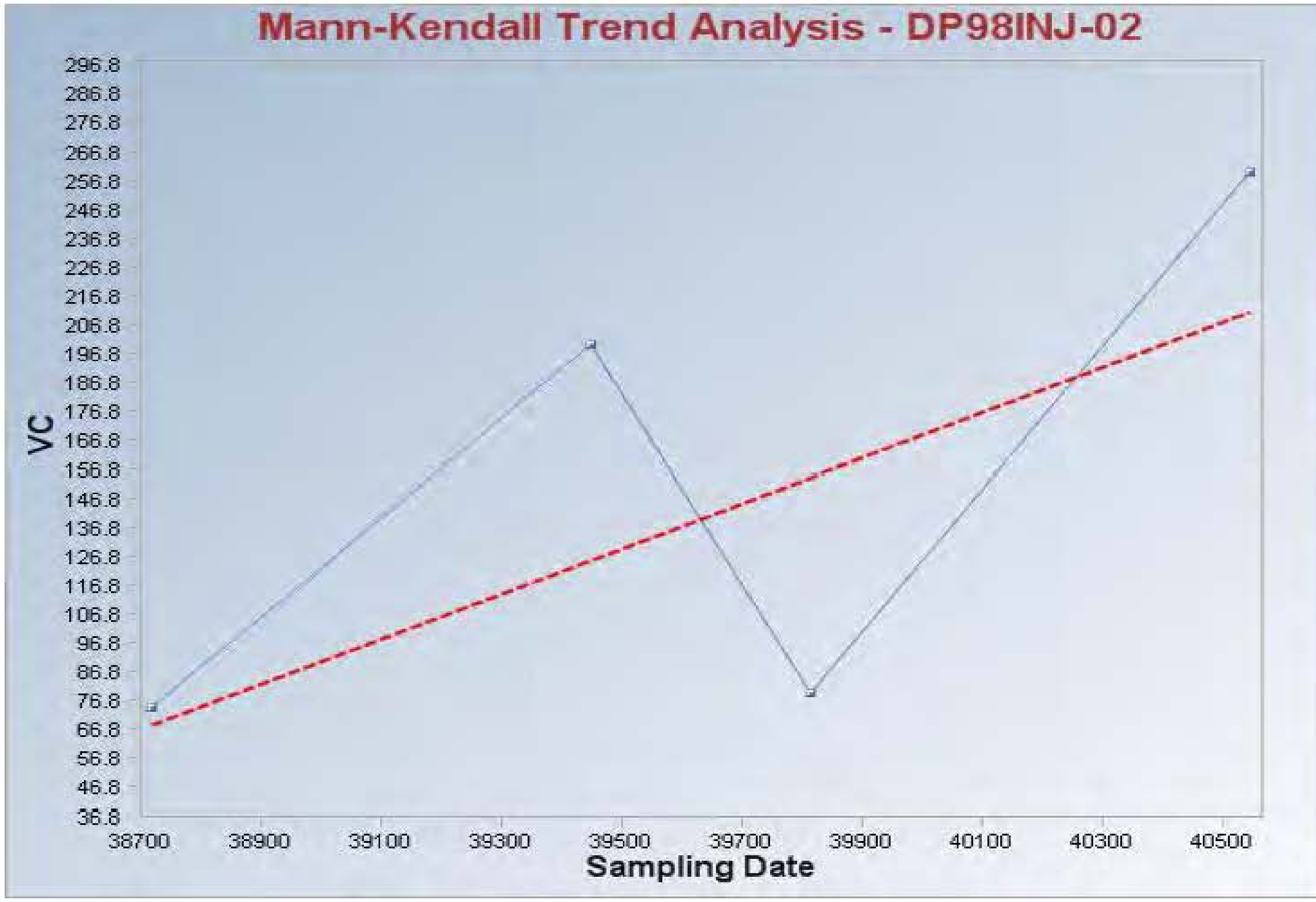
User Selected Options	
Date/Time of Computation	4/9/2013 14:53
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

cis-DCE

General Statistics	
Number of Events	8
Number of Values	8
Minimum	4690
Maximum	11100
Mean	8731
Geometric Mean	8408
Median	8950
Standard Deviation	2364
SEM	835.9

Mann-Kendall Test	
Test Value (S)	7
Tabulated p-value	0.274
Standard Deviation of S	8.021
Standardized Value of S	0.748
Approximate p-value	0.227

Insufficient evidence to identify a significant trend at the specified level of significance.



Mann-Kendall Trend Analysis

n	4.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	4
Tabulated p-value	0.1670
Standard Deviation of S	2.9439
Standardized Value of S	1.0190
Approximate p-value	0.1541

Theil-Sen Trend Line = Red

Theil-Sen Slope	0.0783
Theil-Sen Intercept	-2,963.7365

Insufficient statistical evidence of a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - DP98INJ-02 (VC)

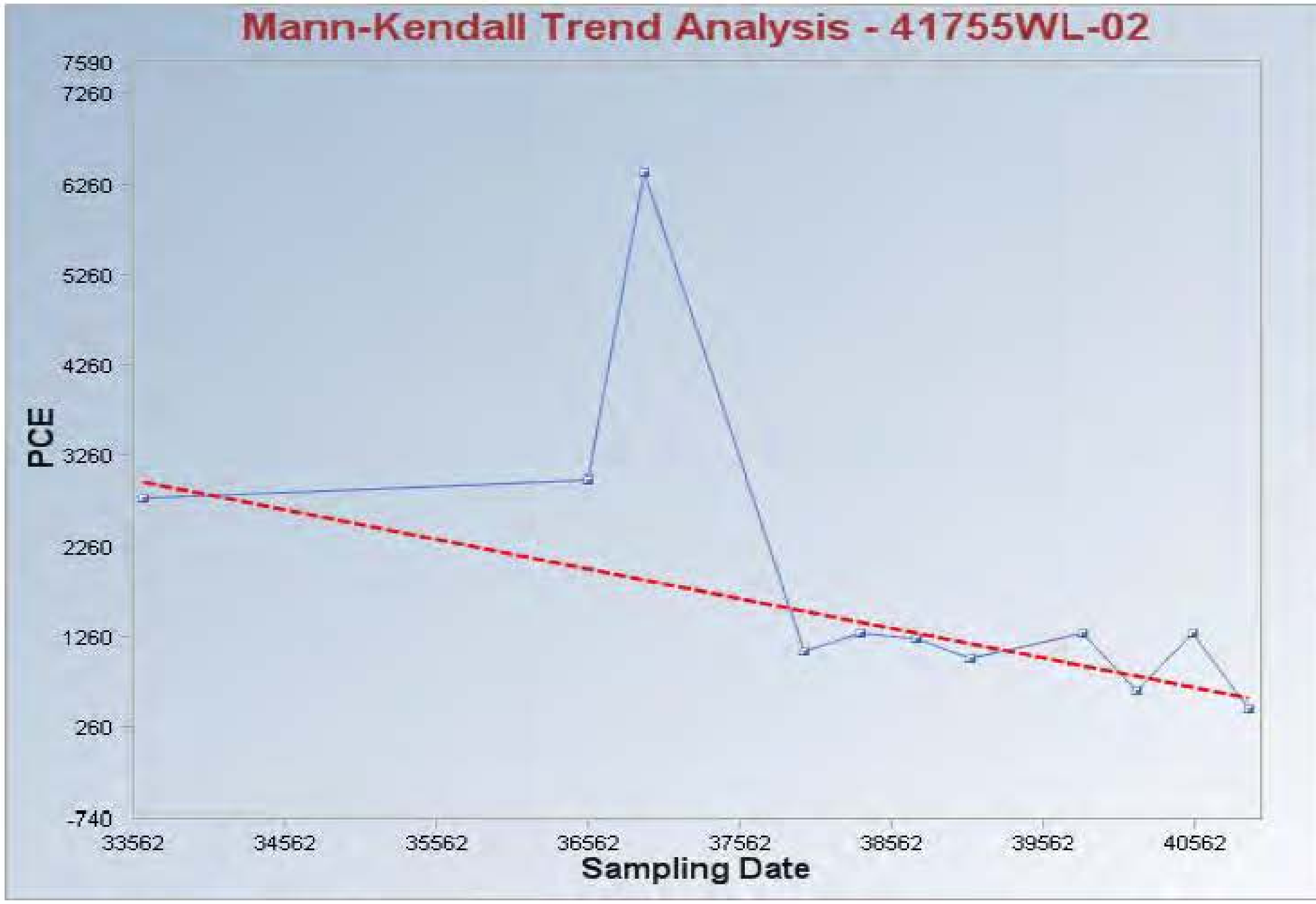
User Selected Options	
Date/Time of Computation	4/9/2013 14:54
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

VC

General Statistics	
Number of Events	4
Number of Values	4
Minimum	74
Maximum	260
Mean	153.3
Geometric Mean	132
Median	139.5
Standard Deviation	91.97
SEM	45.98

Mann-Kendall Test	
Test Value (S)	4
Tabulated p-value	0.167
Standard Deviation of S	2.944
Standardized Value of S	1.019
Approximate p-value	0.154

Insufficient evidence to identify a significant
trend at the specified level of significance.



Mann-Kendall Trend Analysis

n	11.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-28
Tabulated p-value	0.0130
Standard Deviation of S	12.7017
Standardized Value of S	-2.1257
Approximate p-value	0.0168

Theil-Sen Trend Line = Red

Theil-Sen Slope	-0.3285
Theil-Sen Intercept	14,020.6143

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - 41755WL-02 (PCE)

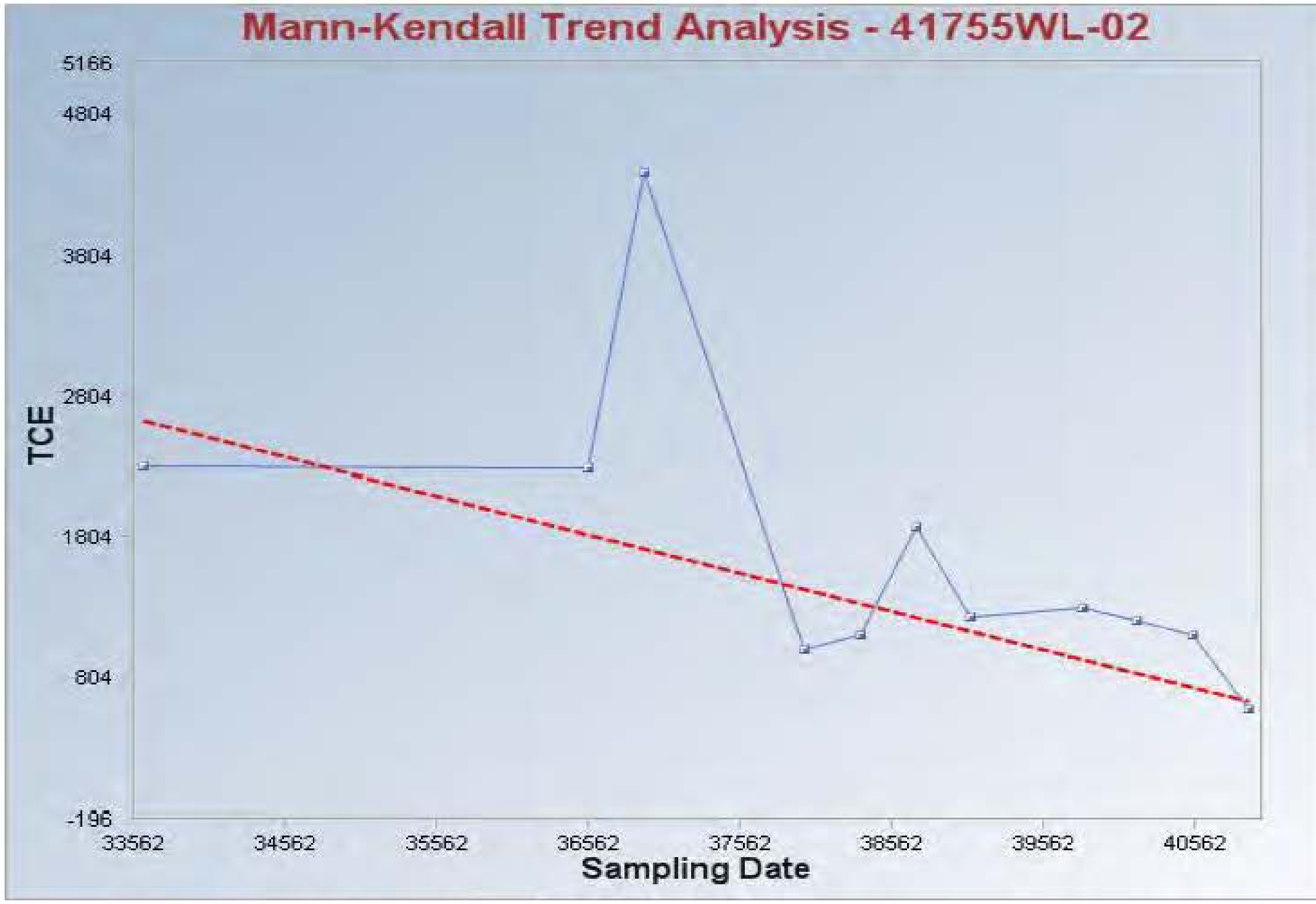
User Selected Options	
Date/Time of Computation	4/9/2013 15:42
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

PCE

General Statistics	
Number of Events	11
Number of Values	11
Minimum	450
Maximum	6400
Mean	1868
Geometric Mean	1422
Median	1300
Standard Deviation	1698
SEM	511.9

Mann-Kendall Test	
Test Value (S)	-28
Tabulated p-value	0.013
Standard Deviation of S	12.7
Standardized Value of S	-2.126
Approximate p-value	0.0168

Statistically significant evidence of a decreasing
trend at the specified level of significance.



Mann-Kendall Trend Analysis

n	11.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-28
Tabulated p-value	0.0130
Standard Deviation of S	12.8062
Standardized Value of S	-2.1083
Approximate p-value	0.0175

Theil-Sen Trend Line = Red

Theil-Sen Slope	-0.2740
Theil-Sen Intercept	11,837.6712

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - 41755WL-02 (TCE)

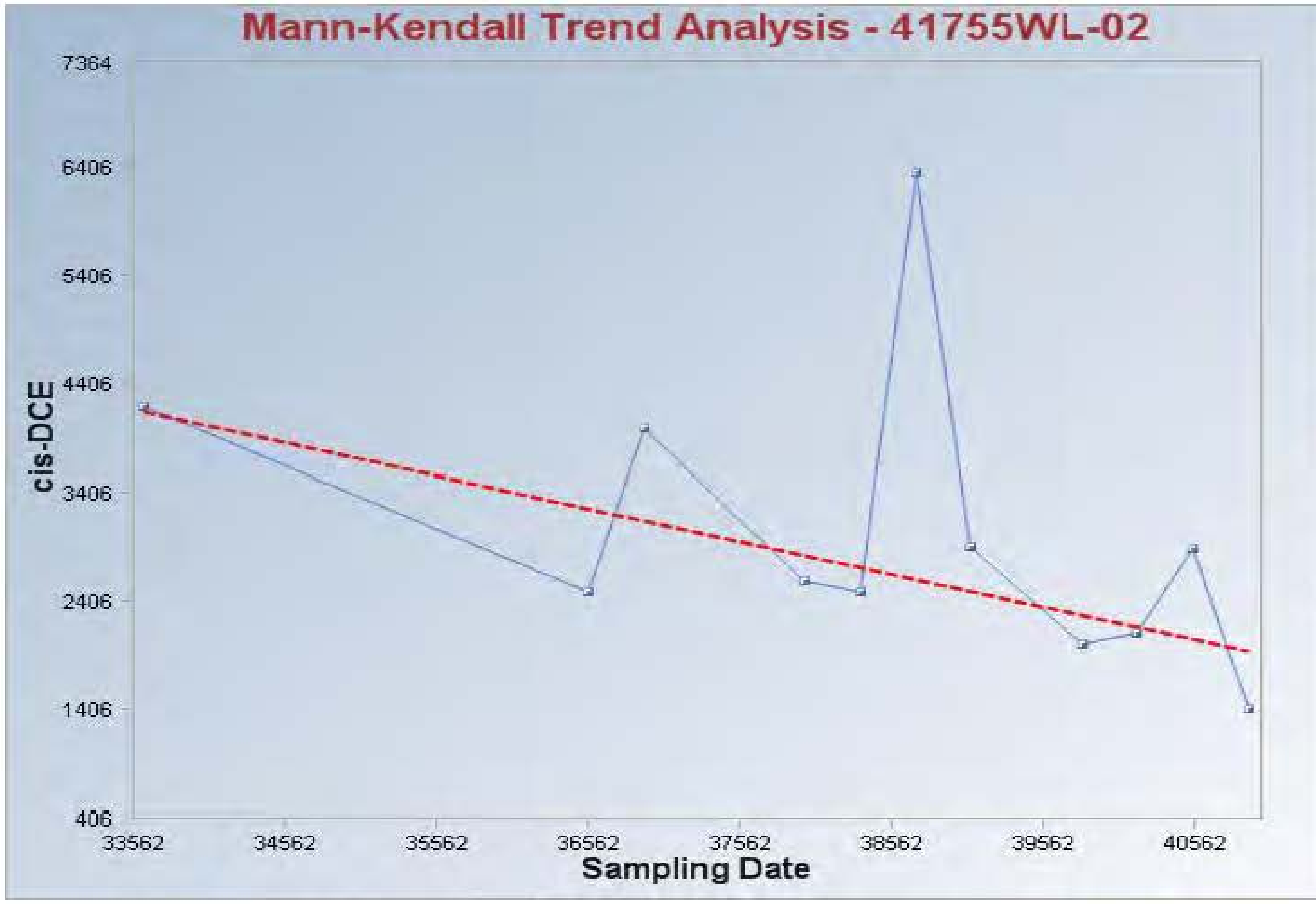
User Selected Options	
Date/Time of Computation	4/9/2013 15:44
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

TCE

General Statistics	
Number of Events	11
Number of Values	11
Minimum	570
Maximum	4400
Mean	1669
Geometric Mean	1445
Median	1230
Standard Deviation	1055
SEM	318.1

Mann-Kendall Test	
Test Value (S)	-28
Tabulated p-value	0.013
Standard Deviation of S	12.81
Standardized Value of S	-2.108
Approximate p-value	0.0175

Statistically significant evidence of a decreasing
trend at the specified level of significance.



Mann-Kendall Trend Analysis

n	11.0000
Confidence Coefficient	0.9500
Level of Significance	0.0500
Test Value (S)	-21
Tabulated p-value	0.0600
Standard Deviation of S	12.8452
Standardized Value of S	-1.5570
Approximate p-value	0.0597

Theil-Sen Trend Line = Red

Theil-Sen Slope	-0.3038
Theil-Sen Intercept	14,361.8890

Insufficient statistical evidence of a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis - 41755WL-02 (cis-DCE)

User Selected Options	
Date/Time of Computation	4/9/2013 15:45
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

cis-DCE

General Statistics	
Number of Events	11
Number of Values	11
Minimum	1400
Maximum	6370
Mean	3043
Geometric Mean	2809
Median	2600
Standard Deviation	1372
SEM	413.8

Mann-Kendall Test	
Test Value (S)	-21
Tabulated p-value	0.06
Standard Deviation of S	12.85
Standardized Value of S	-1.557
Approximate p-value	0.0597

Insufficient evidence to identify a significant trend at the specified level of significance.

APPENDIX H

Historical Number of Wells Sampled and O&M Costs

Table H-1
Number of Wells Sampled at Operable Unit 1, 1998 to 2012

Year	Number of Wells Sampled
1998	13
1999	14
2000	14
2001	12
2002	4
2003	2
2004	2
2005	2
2006	2
2007	2
2008	2
2009	2
2010	2
2011	2
2012	2

Table H-2
Operations and Maintenance Costs for Operable Unit 1, FY1995 through FY2012

Fiscal Year	Groundwater Monitoring	Land-Use Controls Plan	Five-Year Review	Total Costs*
1995	$ 120,000	--	--	$ 120,000
1996	$ 190,000	--	--	$ 190,000
1997	$ 66,000	--	--	$ 66,000
1998	$ 66,000	--	--	$ 66,000
1999	$ 78,000	--	--	$ 78,000
2000	$ 60,000	--	--	$ 60,000
2001	$ 74,000	--	--	$ 74,000
2002	$ 76,228	$ 1,742	$ 2,764	$ 81,000
2003	$ 30,000	--	--	$ 30,000
2004	$ 13,725	--	--	$ 13,725
2005	$ 12,899	--	--	$ 12,899
2006	$ 8,995	--	--	$ 8,995
2007	$ 9,233	--	$ 19,264	$ 28,000
2008	$ 215,684	--	--	$ 215,684
2009	$ 81,632	--	--	$ 81,632
2010	$ 10,369	--	--	$ 10,369
2011	$ 28,184	--	--	$ 28,184
2012	$ 5,438	--	$ 11,063	$ 16,501
			Total Cost:	$ 1,181,370

Note:
*Total costs are rounded to nearest $1,000.

Table H-3
Number of Wells and Seeps Sampled at Operable Unit 2, 1998 to 2012

Year	Number of Wells Sampled	Wetlands Point of Compliance Sampled	Number of Seeps Sampled
1998	14	1	0
1999	14	1	0
2000	13	1	0
2001	12	1	0
2002	5	0	1
2003	3	0	1
2004	3	0	1
2005	3	0	1
2006	2[a]	0	1
2007	5[b]	0	1
2008	0	1	0
2009	6	1	0
2010	3	1	0
2011	3	1	0
2012	7	1	1

Notes:
[a] Three wells scheduled to be sampled in 2006; however, Well ST41-07 was dry.
[b] Six wells are scheduled to be sampled every 5 years; however, Well ST41-34 could not be found.

Table H-4
Operations and Maintenance Costs for Operable Unit 2, FY1995 through FY2012

Fiscal Year	Free Product Recovery System Operation	Groundwater and Seep Monitoring	Land-Use Controls Plan	Five-Year Review	Total Costs*
1994	$ 189,200	--	--	--	$ 189,200
1995	$ 294, 761	--	--	--	$ 295,000
1996	--	$ 38,007	--	--	$ 38,000
1997	$ 92,300	$ 84,000	--	--	$ 176,000
1998	$ 102,647	$ 84,000	--	--	$ 187,000
1999	$ 225,788	$ 74,012	--	--	$ 300,000
2000	--	$ 79,902	--	--	$ 80,000
2001	--	$ 69,126	--	--	$ 69,000
2002	--	$ 72,089	$ 1,792	$ 2,074	$ 76,000
2003	--	$ 53,989	--	--	$ 54,000
2004	--	$ 21,208	--	--	$ 21,000
2005	--	$ 25,079	--	--	$ 25,000
2006	--	$ 29,357	--	--	$ 29,000
2007	--	$ 61,673	--	$ 19,264	$ 81,000
2008	--	$ 32,954	--	--	$ 32,954
2009	--	$ 36,487	--	--	$ 36,487
2010	--	$ 36,021	--	--	$ 36,021
2011	--	$ 19,235	--	--	$ 19,235
2012	--	$ 74,311	--	$ 11,063	$ 85,374
				Total Cost:	$ 1,830,071

Note:
*Total costs are rounded to nearest $1,000.

Table H-5
Number of Wells Sampled at Operable Unit 4, 1998 to 2012

Year	Number of Wells Sampled
1998	13
1999	13
2000	13
2001	7
2002	6
2003	3
2004	3
2005	4
2006	3
2007	4
2008	7
2009	7
2010	5
2011	6
2012	5

Table H-6
Operations and Maintenance Costs for Operable Unit 4, FY1996 through FY2012

Fiscal Year	Free Product Recovery System Operation	Groundwater Monitoring	Land-Use Controls Plan	Five-Year Review	Total Costs*
1996	$ 71,561	$ 114,022	--	--	$ 186,000
1997	--	$ 73,000	--	--	$ 73,000
1998	$ 33,413	$ 73,000	--	--	$ 106,000
1999	$ 91,095	$ 71,043	--	--	$ 162,000
2000	$ 26,904	$ 71,024	--	--	$ 98,000
2001	$ 34,560	$ 74,443	--	--	$ 109,000
2002	$ 72,808	$ 42,052	$ 10,750	$ 12,443	$ 138,000
2003	$ 49,631	$ 42,358	--	--	$ 92,000
2004	$ 36,297	$ 28,070	--	--	$ 64,000
2005	$ 37,289	$ 28,662	--	--	$ 66,000
2006	$94,236	$ 23,440	--	--	$ 118,000
2007	$ 13,137	$ 84,336	--	$ 96,319	$ 194,000
2008	--	$ 89,413	--	--	$ 89,413
2009	--	$ 59,256	--	--	$ 59,256
2010	--	$ 112,989	--	--	$ 112,989
2011	--	$ 101,450	--	--	$ 101,450
2012	--	$ 370,000	--	$ 55,315	$ 425,315
				Total Cost:	$ 2,194,423

Note:
*Total costs are rounded to nearest $1,000.

Table H-7
Number of Wells, Seeps, and Surface Water Locations Sampled at Operable Unit 5, 1998 to 2012

Year	Number of Wells Sampled	Number of Seeps Sampled	Number of Beaver Pond Seeps and Surface Water Locations Sampled	Number of Ship Creek Surface Water Locations Sampled
1998	20	4	1	7
1999	20	4	1	7
2000	20	4	1	7
2001	17	14	4	7
2002	33	11	6	7
2003	28	12	4	2
2004	44	17	4	2
2005	39	17	4	2
2006	39	17	4	2
2007	39	10	4	None
2008	33	11	8	2
2009	33	11	8	2
2010	31	11	8	2
2011	31	10	9	2
2012	30	10	9	2

Table H-8
Operations and Maintenance Costs for Operable Unit 5, FY1995 through FY2012

Fiscal Year	Wetland Remediation System Operation	Groundwater and Seep Monitoring	Land-Use Controls Plan	Five-Year Review	Total Costs
1995	--	$ 51,140	--	--	$ 51,000
1996	--	$ 38,007	--	--	$ 38,000
1997	--	$ 129,000	--	--	$ 129,000
1998	$ 53,827	$ 129,000	--	--	$ 183,000
1999	$ 203,275	$ 119,353	--	--	$ 323,000
2000	$ 225, 317	$ 124,292	--	--	$ 350,000
2001	$ 208,986	$ 106,322	--	--	$ 315,000
2002	$ 212,485	$ 101,193	$ 1,792	$ 2,074	$ 317,000
2003	$ 286,530	$ 162,316	--	--	$ 449,000
2004	$ 437,163	$ 172,188	--	--	$ 609,000
2005	$ 332,110	$ 148,027	--	--	$ 480,000
2006	$ 315,105	$ 98,053	--	--	$ 413,000
2007	$ 104,123	$ 101,558	--	$ 19,264	$ 225,000
2008	--	$ 541,939[1]	--	--	$ 541,939
2009	--	$ 687,309[1]	--	--	$ 687,309
2010	--	$ 824,446[1]	--	--	$ 824,446
2011	--	$ 292,057[1]	--	--	$ 292,057
2012	--	$ 333,136[1]	--	$ 11,063	$ 344,199
				Total Cost:	$ 6,571,950

Note:
*Total costs are rounded to nearest $1,000.
[1] Groundwater and Seep Monitoring costs include costs associated with wetland remediation system operation.

Table H-9
Number of Wells and Seeps Sampled at Operable Unit 6, 1998 to 2012

Year	Number of Wells Sampled	Number of Seeps Sampled
1998	22	0
1999	22	0
2000	20	0
2001	19	0
2002	15	9
2003	9	9
2004	6	9
2005	7	9
2006	9	9
2007	11	5
2008	3	3
2009	13	4
2010	10	4
2011	11	5
2012	6	4

Notes:
PL81 South wells and seeps are included in this table because they provide information about groundwater at LF004 South.

Table H-10
Operations and Maintenance Costs for Operable Unit 6, FY1996 through FY2012

Fiscal Year	HVE System Operation	LF004 Debris Removal	Groundwater and Seep Monitoring	Land-Use Control Plan	Five-Year Review	Total Costs*
1996	--[a]	$ 62,454	$ 152,029	--	--	$ 214,000
1997	$ 81,212	--[b]	$ 123,000	--	--	$ 204,000
1998	--[a]	$ 64,400	$ 117,500	--	--	$ 182,000
1999	$ 137,208	$ 69,475	$ 113,667	--	--	$ 320,000
2000	$ 130,920	$ 359,867[c]	$ 400,034	--	--	$ 891,000
2001	$ 154,168	$ 82,000	$ 116,982	--	--	$ 353,000
2002	$ 171,270	$ 465,105[d]	$ 125,018	$ 9,931	$ 10,037	$ 781,000
2003	$ 31,000	--[b]	$ 139,845	--	--	$ 171,000
2004	$ 206,300	$ 184,280	$ 94,013	--	--	$ 485,000
2005	$ 191,658	$ 73,985	$ 86,428	--	--	$ 352,000
2006	$ 164,815	--[b]	$ 65,999	--	--	$ 231,000
2007	--[a]	$ 49,600	$ 124,891	--	$ 96,319	$ 271,000
2008	--	--	$ 301,214[e]	--	--	$ 301,214
2009	--	--	$ 205,109[e]	--	--	$ 205,109
2010	--	--	$ 166,111[e]	--	--	$ 166,111
2011	--	--	$ 176,960[e]	--	--	$ 176,960
2012	--	--	$ 348,030[e]	--	$ 55,315	$ 403,345
					Total Cost*:	$ 5,707,739

Notes:
Notes continue on the following page
* Total costs are rounded to the nearest $1,000.

[a] The SD015 HVE system operated from December 1996 through May 2007. There is no record to explain the missing O&M costs for 1996, 1998, and 2007, but O&M costs for these years were likely included in other year totals.
[b] Records show LF004 debris removal has been performed annually since 1997. Costs for 1997 were probably provided in 1996 and 2003 costs were included in the 2002 budget. There is no explanation for the missing cost data for 2006.
[c] Cost for LF004 debris removal in FY2000 also includes oral history and erosion studies.
[d] Cost for LF004 debris removal in FY2002 included $380,000 for preparation of Operations Management Plan, which included debris removal in 2003 as part of the plan preparation.
[e] Groundwater and Seep Monitoring costs include costs associated with LF004 debris removal.
[1] The total cost is calculated through 2007.
For definitions, see the Acronyms and Abbreviations section.

Table H-11
Number of Wells and Surface Water Locations Sampled at DP098, 2004 to 2012

Year	Number of Wells Sampled [1]	Number of Seeps Sampled [2]
2004	6	0
2005	6	1
2006	8	1
2007	11	1
2008	2	1
2009	13[a]	1
2010	11	3
2011	8	1
2012	13	0[b]

Notes:
[1] Well sampling frequency varies between one and five years as determined by the Sampling Frequency Decision Tree included as Attachment F, Figure F-2.
[2] Surface water location is at the downstream former kettle pond. Contaminant levels for all contaminants of concern are nondetect (USAF, 2007h).
[a] Two of the wells sampled in 2009 to investigate COC concentrations where monitored natural attenuation may not be progressing were temporary wellpoints.
[b] The point of compliance (DP98SW-01) could not be located during 2012 sampling activities.

Table H-12
Operations and Maintenance Costs for DP098, FY2004 through FY2012

Fiscal Year	Groundwater and Seep Monitoring	Treatability Study	Five-Year Review	Total Costs*
2004	$ 44,918	$ 1,000	--	$ 46,000
2005	$ 45,145	$ 87,200	--	$ 132,000
2006	$ 36,843	$ 39,400	--	$ 76,000
2007	$ 92,511[a]	$ 22,449	$ 19,264	$ 134,000
2008	$ 178,162	--	--	$ 178,162
2009	$ 67,381	--	--	$ 67,381
2010	$ 70,252	--	--	$ 70,252
2011	$ 49,400	--	--	$ 49,400
2012	$ 85,997	--	$ 11,063	$ 97,060
			Total Cost:	$ 850,255

Notes:
*Total costs to the nearest $1,000
[a] Increase in cost of monitoring in 2007 corresponds to increase in number of wells sampled.

2008 - 2012 O+M Costs for CERCLA Sites

Operable Unit 1

Fiscal Year	Groundwater Monitoring	Five-Year Review	Total Costs
2008	$215,684.00		$215,684.00
2009	$81,632.00		$81,632.00
2010	$10,369.00		$10,369.00
2011	$28,184.00		$28,184.00
2012	$5,438.00	$11,063.00	$16,501.00
Totals	$341,307.00	$11,063.00	$352,370.00

Operable Unit 2

Fiscal Year	Groundwater and Seep Monitoring	Five-Year Review	Total Costs
2008	$32,954.00		$32,954.00
2009	$36,487.00		$36,487.00
2010	$36,021.00		$36,021.00
2011	$19,235.00		$19,235.00
2012	$74,311.00	$11,063.00	$85,374.00
Totals	$199,008.00	$11,063.00	$210,071.00

Operable Unit 4

Fiscal Year	Groundwater Monitoring	Five-Year Review	Total Costs
2008	$89,413.00		$89,413.00
2009	$59,256.00		$59,256.00
2010	$112,989.00		$112,989.00
2011	$101,450.00		$101,450.00
2012	$370,000.00	$55,315.00	$425,315.00
Totals	$733,108.00	$55,315.00	$788,423.00

2008 - 2012 O+M Costs for CERCLA Sites

Operable Unit 5

Fiscal Year	Groundwater and Seep Monitoring[1]	Five-Year Review	Total Costs
2008	$541,939.00		$541,939.00
2009	$687,309.00		$687,309.00
2010	$824,446.00		$824,446.00
2011	$292,057.00		$292,057.00
2012	$333,136.00	$11,063.00	$344,199.00
Totals	$2,678,887.00	$11,063.00	$2,689,950.00

[1] Groundwater Monitoring category includes Wetland Remediation System operation for Fiscal Years 2008-2012.

Operable Unit 6

Fiscal Year	Groundwater and Seep Monitoring[1]	Five-Year Review	Total Costs
2008	$301,214.00		$301,214.00
2009	$205,109.00		$205,109.00
2010	$166,111.00		$166,111.00
2011	$176,960.00		$176,960.00
2012	$348,030.00	$55,315.00	$403,345.00
Totals	$1,197,424.00	$ 55,315.00	$1,252,739.00

[1] Groundwater Monitoring category includes LF04 Debris Removal for Fiscal Years 2008-2012.

DP098

Fiscal Year	Groundwater and Seep Monitoring	Five-Year Review	Total Costs
2008	$178,162.00		$178,162.00
2009	$67,381.00		$67,381.00
2010	$70,252.00		$70,252.00
2011	$49,400.00		$49,400.00
2012	$85,997.00	$11,063.00	$97,060.00
Totals	$451,192.00	$11,063.00	$462,255.00

APPENDIX I

EPA and ADEC Concurrence Emails *(provided)* **&**

ST37 TCE Plume and Source Area Investigation Report (Draft-Final)

(available on CD – click the link above to open)

From:	Gusmano.Jacques@epamail.epa.gov
To:	Baumler, Donna G Civ USAF PACAF 673 CES/CEANR
Cc:	Howard, Louis R (DEC)
Subject:	RE: draft final ST37 report
Date:	Thursday, November 10, 2011 9:00:34 AM

EPA also approves the ST37 Report.
It looks like we have significant follow-up work to discuss as a result of this Report.
This and SS-22 will be important agenda items at the next FFA.

From:	Howard, Louis R (DEC)
To:	Baumler, Donna G Civ USAF PACAF 673 CES/CEANR
Cc:	Jacques Gusmano
Subject:	draft final ST37 report
Date:	Thursday, November 10, 2011 7:24:24 AM

After reviewing the ST37 Draft Final version of the ST37 TCE Plume and Source Area Investigation Report, it appears the comments submitted by the department on October 31, 2011 have been adequately addressed and the department will approve it as a final version pending incorporation of any EPA comments.

Please let me know if this email will suffice or if you need a hard copy letter mailed to you.

Louis Howard
State of Alaska
Dept. of Environmental Conservation
Contaminated Sites Program
Federal Facilities Environmental Restoration
555 Cordova St 2nd fl.
Anchorage AK 99501-2617
Phone: (907) 269-7552
Facsimile: (907) 269-7649
louis.howard@alaska.gov

From: Baumler, Donna G Civ USAF PACAF 673 CES/CEANR [mailto:Donna.Baumler@elmendorf.af.mil]
Sent: Wednesday, August 10, 2011 2:46 PM
To: Howard, Louis R (DEC)
Subject: Thanks

Louis –

Thanks, I received your comments on the Ship Creek Hydrology Near LF59 and Optimization of Early Warning and Sentry Well Quality Program Plan. I will forward these to the contractor today.

Thanks,

DONNA G. BAUMLER, GS-12
Remedial Project Manager

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